Award of 1492-1517 MHz spectrum for mobile services

Consultation on Ofcom's proposals

Consultation

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For more information on this publication, please visit https://www.ofcom.org.uk/spectrum/innovative-use-of-spectrum/call-for-input-1.4-ghz-band-available-for-mobile

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Annex

1. Overview

1.1 This document sets out our proposals to auction the upper block of the 1.4 GHz band (1492-1517 MHz) for 4G and 5G mobile use.

1.2 1.4 GHz spectrum has been harmonised for international mobile telecommunications ("**IMT**") use, and 40 MHz of this spectrum (1452-1492 MHz) has already been deployed by mobile network operators ("**MNOs**") in the UK. We expect that deployment of the 25 MHz upper block will improve the performance of mobile services for consumers, particularly where coverage is patchy, for example indoors and in rural areas.

What we are proposing – in brief

We are proposing:

- to award the upper block of the 1.4 GHz band for IMT services;
- to set limits on mobile network transmission power at certain ports and airports for an initial period, in order to avoid risk of disruption to maritime and aviation operations from potential blocking[1] of some Inmarsat satellite receivers on board ships and aircraft. We would relax these limits after the initial period;
- not to protect Inmarsat land-based satellite receivers or future uses of the 1.5 GHz band from potential disruption; and
- to use a sealed bid single round auction format with a second price rule for the auction.

1.3 We are consulting on whether the initial period for stricter limits on mobile networks transmission power at the ports and airports should be either relatively short (around five years) or longer (up to twenty years). If we opt for the shorter period, which we currently prefer, maritime vessel operators and airlines would need to upgrade or replace the Inmarsat receivers most at risk from blocking.

1.4 We welcome comments on our proposals by **25 April 2025**.

1.5 We intend to consult separately on our competition assessment for this award, once any trades which are being considered as part of the merger between H3G and Vodafone have been completed.

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

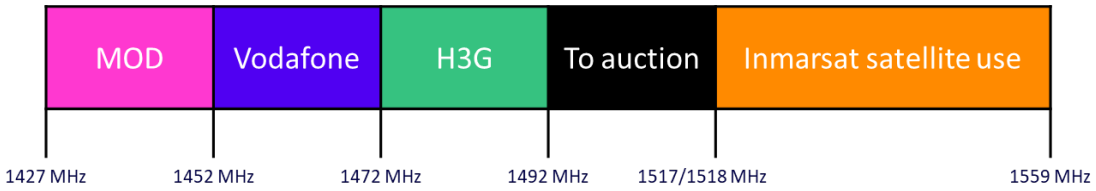
[1] In this document we use the term "blocking" to refer to a situation in which an unwanted signal significantly reduces a receiver's sensitivity to a wanted signal.

2. Summary

The 1.4 GHz spectrum band

2.1 As shown in Figure 2.1 below, the centre of the 1.4 GHz band, from 1452-1492 MHz, is already licensed to Vodafone and H3G respectively. The focus of this consultation is the spectrum between 1492-1517 MHz. We refer to this as the "**upper block of the 1.4 GHz band**". The range 1517-1518 MHz is assigned for Programme Making and Special Event ("**PMSE**") use.

Figure 2.1: the 1.4 GHz band and the adjacent 1.5 GHz band



2.2 The upper block of the 1.4 GHz band was first identified for mobile use at the World Radio Conference in 2015 and was harmonised for mobile use in the EU by Commission Implementing Decision (EU) 2018/661 of 26 April 2018.

Satellite receivers in the adjacent 1.5 GHz band

2.3 The adjacent block of spectrum in the 1.5 GHz band (1518-1559 MHz) is currently used by Inmarsat on a licence exempt basis for the satellite to earth segment of some mobile satellite services ("**MSS**", also known as "**Satcom**") on maritime vessels, aircraft and on land. Some satellite terminals receiving in this band, specifically those using the Inmarsat network and especially older terminal models, are susceptible to blocking from mobile network transmissions at frequencies below 1518 GHz.

2.4 Some of these Inmarsat terminals play an important role in the safe operation of maritime and aviation services respectively. Specifically, many installed Inmarsat terminals are part of the Global Maritime Distress and Safety System ("**GMDSS**"), which is mandatory for certain vessels engaged on international voyages, including ships carrying more than 12 passengers and large cargo ships. Inmarsat terminals are also often installed on aircraft, including as part of flight systems used when flights are in busy air corridors, most notably across the Atlantic Ocean. Various land-based terminals also have satellite receivers which connect to the Inmarsat network.

2.5 The European Conference of Postal and Telecommunications Administrations ("**CEPT**") studied the potential for blocking of MSS receivers which use the 1518-1559 MHz range by IMT base stations transmitting in the 1492-1517 MHz range. It recommended protection measures that CEPT members could put in place to protect MSS receivers. It proposed two phases of protection around ports and airports: in Phase 1 the worst performing receivers

would be protected for a transition period, after which, in Phase 2, only the better performing receivers would be protected.[2]

Our duties and objectives

Our duties

2.6 Our principal duty is to further the interests of citizens and consumers, where appropriate by promoting competition. In doing so, we are required to secure the optimal use of spectrum, which in this case includes the 1492-1517 MHz band we intend to award as well as the use of the upper adjacent band used for MSS. In carrying out this assessment, we have taken into account our statutory duties identified in Annex A5, including:

a) the desirability of encouraging investment and innovation as well as promoting economic growth;
b) the Government's current Statement of Strategic priorities which identifies a further objective of improving mobile coverage and a strategic priority to promote new 5G services through the release of additional spectrum;
c) the desirability of promoting efficient use of the 1492-1517 MHz band by mobile operators;
d) the economic and other benefits that may arise from use of the band for mobile; and
e) the different needs and interests of users of the adjacent bands and whether our proposals are proportionate and do not therefore impose adverse impacts on users of the adjacent bands which outweigh the benefits of use of the band for mobile.

Our objectives

2.7 Our objectives for this award, which are derived from our duties, are to:

a) achieve **optimal use of spectrum**, which we consider includes:
    i) making the spectrum available for mobile use to bring new economic and social benefits for people and businesses;
    ii) allocating the spectrum to the most efficient user; and
    iii) ensuring that appropriate protections are put in place for systems using adjacent frequency bands.
b) sustain strong **competition** in mobile markets;
c) ensure **timely availability** of spectrum; and
d) enable improved **connectivity** for consumers.

[2] The CEPT published its findings in ECC Report 299.

Summary of our proposals

Protection of adjacent band satellite receivers

2.8 To avoid the potential for significant disruption to the aviation and maritime sectors, we propose to protect for a limited period the Inmarsat receivers on board maritime vessels and aircraft most susceptible to blocking at certain ports and airports, and to relax the protections as soon as practical thereafter. We are consulting on two options:

a) **Option A** would be an accelerated upgrade process over a relatively short Phase 1 period, around five years from the date of our final decision. In order to avoid the risk of blocking once restrictions are relaxed to Phase 2 levels, we would expect maritime vessel operators and airlines to replace or upgrade the Inmarsat receivers most at risk within the specified period.

b) **Option B** would be a natural retirement and upgrade process, taking up to 20 years to transition from Phase 1 to Phase 2 restrictions, starting from the date of our final decision. In order to avoid the risk of blocking, we would expect maritime vessel operators and airlines to upgrade the Inmarsat receivers most at risk from blocking within the specified period, most likely at the point that the affected terminal would naturally be retired.

2.9 Option A would maximise the benefit to mobile phone users and network operators. However, shipping companies, airlines and Inmarsat would need to ensure that the satellite receivers most at risk from blocking at ports and airports are upgraded, to avoid disruption to their operations in the UK.

2.10 Option B would delay substantially much of the benefit to mobile phone users and network operators, whilst the number of satellite receivers most at risk from blocking would gradually decrease as older maritime vessels and aircraft are withdrawn from service at the end of their useful life. Shipping companies, airlines and Inmarsat would need to take little or no specific action to avoid blocking of MSS receivers at UK ports and airports.

2.11 Our current view, subject to considering stakeholders' responses, is that Option A would be more appropriate and consistent with our objectives.

2.12 As explained in Section 4, we do not propose to protect land-based satellite receivers, PMSE users or future uses of the 1.5 GHz band from potential disruption.

Coordination

2.13 In order to protect adjacent band satellite receivers, we propose to define power flux density ("**PFD**") limited zones within which mobile operators would be required to limit the power of their transmissions; as well as coordination zones surrounding the PFD limited zones within which mobile licensees would need to design their deployments to ensure that they do not exceed the PFD limits within the PFD limited zones.

2.14 We propose to define PFD limited zones around protected ports and international airports. We would require licensees to perform coordination calculations for each base station deployment that falls within a coordination zone to ensure the planned deployment would not exceed the PFD limit within the PFD limited zone.

2.15 The PFD limits would be those recommended in Table 13 of ECC Report 299 as shown in Table 2.1. They are proposed in two phases, where Phase 1 limits would be required initially from the award of the spectrum. Phase 2 limits would be adopted once protections are relaxed.

Table 2.1. Proposed PFD limits to be applied around protected ports and airports

	Phase 1 PFD limits (dBW/m^2)		Phase 2 PFD limits (dBW/m^2)	
Ports	-74.9	-85.9	-30.9	-40.9
Airports	-53.5	-63.4	-30.9	-40.9

2.16 Our modelling shows that deployments around ports could breach the Phase 1 PFD limits within port PFD limited zones at ranges of around 30 km, and that this would reduce to around 2 km once Phase 2 PFD limits are in place.

2.17 Around airports, our modelling shows that deployments could generate a PFD above the limits within airport PFD limited zones at ranges of up to 20 km while Phase 1 PFD limits are in place, reducing to approximately 2 km once Phase 2 PFD limits are in place.

2.18 We are seeking stakeholders' views on the following options for defining coordination zones around ports and airports:

a) **Option 1**: no specific coordination zones - licensees would be required to use their own judgement to decide where coordination is necessary;
b) **Option 2**: circles defined by a radius around a central point;
c) **Option 3**: a polygon around a PFD limited zone; and
d) **Option 4**: a series of grid squares.

2.19 We propose to require licensees to carry out the coordination calculations, using a coordination method and parameters provided by us. We would require licensees to retain the results of their coordination calculations and make them available to us upon request.

Auction design

2.20 We propose to auction the spectrum using a **sealed bid, single round** auction format, with a second price rule. Bidding would be conducted in a single round, with the highest value bid or highest value combination of bids selected as the winning bids.

2.21 We propose to set a reserve price of £1 million per 5 MHz, and propose to offer the following five bidding options to each bidder:

a) the lower 10 MHz;
b) the upper 15 MHz;
c) the whole 25 MHz block;
d) the lower 5 MHz; and
e) the upper 20 MHz.

Licence Conditions

2.22 We propose to award licences of indefinite term to use this spectrum, which we would be able to revoke on spectrum management grounds with five years' notice, to expire no earlier than 20 years after the award.

2.23 We propose to include all our **normal technical and non-technical licence conditions** in the award licences, as well as additional licence conditions to implement the coordination proposals explained above.

Structure of this document

2.24 The remainder of this document is structured as follows:

- Section 3: Protection of satellite receivers on maritime vessels and aircraft
- Section 4: Protection of other adjacent band users
- Section 5: Coordination
- Section 6: Technical licence conditions
- Section 7: Non-technical licence conditions
- Section 8: Auction design

2.25 This consultation also includes the following Annexes:

- Annex 1: Responding to this consultation
- Annex 2: Ofcom's consultation principles
- Annex 3: Consultation coversheet
- Annex 4: Consultation questions
- Annex 5: Legal framework
- Annex 6: Detailed summary of responses regarding protection of adjacent band satellite receivers on maritime vessels and aircraft
- Annex 7: Further detail on our maritime proposals
- Annex 8: Further detail on our aviation proposals
- Annex 9: Draft award licence
- Annex 10: Draft coordination procedures
- Annex 11: Example PFD limited zones
- Annex 12: Draft interface requirements
- Annex 13: Illustrative auction procedures
- Annex 14: In depth review of all bidding options

Next steps

2.26 We invite responses to this consultation by 25 April 2025.

3. Protection of adjacent band satellite receivers on maritime vessels and aircraft

Summary

3.1 In this section we set out our proposed approach to protection of adjacent band satellite receivers from IMT use of 1492-1517 MHz. In summary, we propose to award nationwide licence(s) that are subject to coordination requirements around (a) 32 international airports; and (b) either 160 major and minor ports in the UK identified by the Department for Transport, or only the 51 major ports (our preferred option). We are also consulting on options for relaxing these coordination requirements after a relatively short period of approximately five years (our preferred option) or a longer period of up to 20 years.

3.2 Recognising that the Ministry of Defence uses Inmarsat satellite receivers on military vessels and aircraft, and the critical role that it plays in national security, we are also proposing to protect approximately 10 military sites.

3.3 In making these proposals we are seeking to maximise the opportunity for efficient use of the spectrum for mobile services while providing proportionate protection to vulnerable receivers on maritime vessels and aircraft until they are upgraded.

3.4 We set out our proposed approach to other adjacent band users in Section 4.

Background

Benefits of making more 1.4 GHz spectrum available for mobile use

3.5 We consider that the upper block of the 1.4 GHz band will enable mobile operators to improve the quality of their services to consumers.

3.6 This spectrum has been internationally harmonised for 'supplementary downlink' ("**SDL**") use. This means that it can only be used for 'downlink' purposes (i.e. for transmitting data from a base station to a user's device). We expect that if mobile network operators ("**MNOs**") deploy the upper block of the 1.4 GHz band in their networks, consumers will see improved coverage, speeds and performance in locations where coverage relies on low frequency spectrum – for example indoors, at the edges of macrocells and in rural areas.

3.7 We note that the MNOs already licenced to use the centre block of the 1.4 GHz band have deployed this spectrum.[3] In addition, the ecosystem for use of this spectrum is growing at pace: 1432-1517 MHz has been supported in some major handsets, such as the iPhone and Samsung Galaxy, for the last 2-3 years.[4]

Satellite receivers in the adjacent 1.5 GHz band

3.8 The adjacent block of spectrum in the 1.5 GHz band (1518-1559 MHz) is currently used by Inmarsat on a licence exempt basis for the satellite to earth segment of some mobile satellite services ("**MSS**", also known as "**Satcom**") on maritime vessels, aircraft and on land. Existing Inmarsat satellite receivers operating in this band, especially older terminal models, are susceptible to blocking from mobile network transmissions at frequencies below 1518 GHz.

3.9 Some of these Inmarsat terminals play an important role in the safe operation of maritime and aviation services respectively. Specifically, Inmarsat C terminals are part of the Global Maritime Distress and Safety System ("**GMDSS**"). This system is mandatory for certain maritime vessels engaged on international voyages, including vessels on international voyages carrying more than 12 passengers and large cargo ships. Inmarsat terminals are also often installed on aircraft, including as part of flight systems used when flights are in busy air corridors across the Atlantic Ocean.

3.10 There are many different terminal models and the susceptibility of their receivers to blocking by IMT transmissions in the upper block of the 1.4 GHz band varies considerably. The data we have shows that, in general, older models are more susceptible to blocking and newer models are more resilient to blocking.

3.11 We understand receivers which are resilient in the presence of Phase 2 protection levels have been available for over 10 years [CONFIDENTIAL ✂],[5] but older, less resilient, models are still in use on maritime vessels and aircraft (and continue to be sold). Protecting the most susceptible receivers would make it more difficult for mobile operators to deploy the spectrum in large parts of the UK's landmass.

3.12 We understand that the cost of upgrading the more susceptible receivers is likely to fall on the maritime and aviation industries.

Ofcom's spectrum strategy

3.13 Inmarsat's satellite receivers operate in the 1518-1559 MHz block, and not in the 1492-1517 MHz block which we are proposing to make available for mobile services. Where there is material risk to the operation of some of these receivers, it does not arise from the

[3] Vodafone CFI response to Q1, H3G 2019 announcement of its plans to deploy 1.4 GHz frequencies on a nationwide basis.

[4] Currently 174 user device models support 1432-1517 MHz. This is an increase from 72 in 2023 and 18 in 2022. It has also been supported in some major handsets for the last 2-3 years, including the iPhone (15, 16) and Samsung Galaxy (S22, S23, S24). Global Mobile Suppliers Association's Analyser for Mobile Broadband Data ("**Gambod**"), accessed 24 January 2025.

[5] Paragraph 3.76

potential for mobile base station transmitters in the 1492-1517 MHz block generating interference into the frequencies used by Inmarsat's receivers. Rather, it arises from the high sensitivity of some of Inmarsat's receivers to mobile base station transmissions *within* the 1492-1517 MHz block. This sensitivity can be avoided by appropriate design of the receivers, as evidenced by the existence of current Inmarsat receiver models measured to be far less sensitive to those transmissions.[6]

3.14 Ofcom is responsible for managing the UK's radio spectrum, to ensure that it is used efficiently. We consider that the appropriate way to address the potential blocking of some Inmarsat receivers would be to upgrade those receivers, rather than to significantly and unduly limit mobile networks' deployment of the upper block of the 1.4 GHz band.

3.15 In this regard, we set out in our spectrum management strategy for the 2020s that ever greater demand for spectrum means that frequencies need to be used as efficiently as possible.[7] In particular, we said that it is essential to encourage spectrum users to be more resilient to interference, and that we would not generally expect to take action on interference if it is a result of the poor performance of receivers or wider systems.[8]

International Analysis

3.16 The European Conference of Postal and Telecommunications Administrations ("**CEPT**") and the International Telecommunications Union ("**ITU**") have studied the potential for blocking from terrestrial mobile network base stations offering SDL services in the 1492-1517 MHz block into existing satellite receivers using the 1518-1559 MHz block.

CEPT

3.17 CEPT set out its conclusions in ECC Report 299 and recommended protection measures that CEPT members could put in place to protect satellite receivers. It proposed two different levels of protections: "**Phase 1**" protections, designed to protect the worst performing receivers, and "**Phase 2**" protections, designed to protect the better performing receivers. It proposed that these protections should be established around ports and airports, and there should be a transition period between the two phases. It suggested that the timing of the transition should "facilitate satellite operators preparing retrofit operations for terminals/users requiring protection" and recommended that the "timing for closure of services" should be based on "Inmarsat's public service obligations, which is typically 5-7 years".[9]

[6] We requested data from Viasat regarding the resilience of its MSS receivers to blocking. We assessed the data provided for each model against the limits in Table 13 of ECC Report 299 and established which models were most resilient to blocking; Viasat, 10 September 2024 response to Ofcom's August 2024 statutory information request, [CONFIDENTIAL ✂].

[7] Ofcom, "Supporting the UK's wireless future: our spectrum management strategy for the 2020s" ("**Spectrum Management Strategy**"), para 2.3.

[8] Ofcom, Spectrum Management Strategy, para 3.66.

[9] ECC Report 299, section 4.5: Timing for protection of MES terminals.

ITU

3.18 The ITU has also considered coexistence in this band. ITU-R issued report ITU-R M.2529-0 and recommendation ITU-R M 2159-0 in December 2023, which draw from several studies including the CEPT work. It sets out two options for the protection of satellite receivers, with the ECC Report 299 recommendations forming the most stringent of these, assuming a 3 dBi fixed MSS antenna gain. The second option is based on earlier measurements of MSS susceptibility conducted by the United States Federal Communications Commission, resulting in higher (less stringent) PFD limits at both Phase 1 and Phase 2.

CFI proposal

3.19 In October 2023 we published a call for input ("**CFI**") on technical analysis we had conducted to estimate the likely extent of blocking of Inmarsat's receivers, and on our initial views of the measures we could take to mitigate the blocking risk. We proposed to impose coordination zones and PFD limited zones around all of the UK's ports and airports, as recommended by ECC Report 299. The areas in which we proposed coordination would be required to ensure compliance with PFD limits were very significant, covering large portions of the UK's landmass.[10]

High level summary of responses to the CFI

3.20 We received mixed responses to the CFI, with satellite stakeholders generally preferring more restrictions, and mobile stakeholders generally encouraging us to reduce the extent of restrictions on mobile use:

a) **Viasat** (Inmarsat's parent company) and the Maritime and Coastguard Agency ("**MCA**") encouraged greater restrictions on the basis that the coexistence analysis should be extended to include maritime and aviation operations outside of airports and ports, and land-based terminals.
b) **John Shaw** said that the proposals failed to appreciate the extent to which air and sea traffic needs to have a clear path for navigation to and from ports and airports, over which communications must be maintained.
c) The **MNOs** and the Global System for Mobile Communications Association ("**GSMA**") accepted the need for PFD limits and coordination in principle; however, they thought that our proposals may be too conservative. **BT/EE** and the **GSMA** suggested that Ofcom should consider the experience of other administrations, both citing Denmark where protections have been implemented at airports, but not ports. **H3G** suggested that Ofcom target coordination requirements at the ports and airports where blocking is most likely.

[10] Ofcom, October 2023 CFI, p. 19, Figure 9.

d) The MCA and John Shaw argued that the loss of spectrum above 1518 MHz on account of blocking and out-of-band emissions would compromise the viability of MSS services and lead to reduced competition.[11,12]

3.21 A more detailed summary of responses is in Annex A6.

Summary of our current assessment

3.22 In light of stakeholders' responses to the CFI and our own further analysis and stakeholder engagement, we have reconsidered whether restrictions on mobile use of this spectrum in order to protect satellite receivers are appropriate, and if so, how significant such restrictions should be, and how long they should remain in place. Our provisional view is that making this spectrum available for mobile use without protection around certain ports and airports could cause significant disruption which could have an adverse effect on consumers, depending on how resilient affected MSS receivers are to blocking from IMT use. Therefore, we consider that it would be appropriate to impose restrictions on mobile use at and around certain ports and airports, to protect Inmarsat's satellite receivers.

3.23 In line with the terminology used in ECC Report 299, we propose to define two phases in the licences we would award for mobile network use of the spectrum:

- Phase 1 would start on the date of grant of the licences. During Phase 1, stringent limits would apply to the power mobile networks will be able to transmit into certain ports and airports, to protect even the most susceptible MSS receivers from blocking.
- Phase 2 would start at the end of Phase 1. During Phase 2, the limits on the power mobile networks will be able to transmit into ports and airports would be relaxed considerably, to protect only the more resilient MSS receivers from blocking.

3.24 The benefits of making the spectrum available for mobile services, as well as the value of the spectrum to mobile networks, are likely to be significantly impacted by the duration of Phase 1.

3.25 We are considering two options for setting the duration of Phase 1.

3.26 One option ("**Option A**") would be an accelerated upgrade process over a relatively short Phase 1 period, around five years from the date of our final decision. In order to avoid the risk of blocking once restrictions are relaxed to Phase 2 levels, we would expect maritime vessel operators and airlines to replace or upgrade the Inmarsat receivers most at risk within the specified period.

3.27 An alternative ("**Option B**") would be a natural retirement and upgrade process, taking up to 20 years to transition from Phase 1 to Phase 2 restrictions, starting from the date of our final decision. In order to avoid the risk of blocking, we would expect maritime vessel operators and airlines to upgrade the Inmarsat receivers most at risk from blocking within

[11] MCA, CFI response, p. 5, Q. 2; Shaw J, CFI response, p. 3, Q. 1 and p. 6, Q. 4.

[12] We note that this reduced access would be a result of vulnerable receivers, which we expect will be upgraded, as opposed to reduced spectrum access. We do not consider that competition based on the quality of products to be unfair competition.

the specified period, most likely at the point that the affected terminal would naturally be retired.

3.28 In Option A, the maritime and aviation industries, and potentially Inmarsat, would incur costs sooner than they would otherwise have been incurred, without readily identifiable benefits for themselves, other than avoiding risks of operational disruption during Phase 2. The costs are likely to be incurred regardless of any decisions we may take in relation to the 1.4 GHz band. This is because equipment will eventually need to be replaced as part of normal lifecycles and/or to avoid blocking that may occur at non-UK ports and airports where the spectrum is made available for mobile with no, or limited restrictions. Mobile networks would be able to deploy the spectrum to maximise benefits to mobile consumers as soon as reasonably practicable.

3.29 In Option B, the maritime and aviation industries would not incur these accelerated costs and would not carry any material additional risk of operational disruption. However, mobile networks would need to constrain their deployment of the spectrum for up to 20 years, delaying the benefits to mobile consumers for approximately 15 years.

3.30 Our current assessment is that Option A would be more likely to secure the optimal use of spectrum, for two reasons. First, while in Option A the maritime and aviation industry would incur accelerated costs, the benefits to mobile consumers would be ongoing and endure for approximately 15 years. Second, in Option B, we provisionally consider that it would be inefficient to allow investment and improvements in the quality of mobile phone services used by millions of consumers to be held back by outdated technology in some MSS terminals while up to date more resilient alternatives are available. Overall, we provisionally consider that the benefits of making the spectrum available for IMT sooner under Option A outweigh any potential adverse impacts on the maritime and aviation industries. We have explained the basis for both Options A and B in more detail below in the section “Reducing restrictions from Phase 1 to Phase 2” as well as Annexes A7 and A8.

Our assessment framework

Structure of our assessment

3.31 Our primary policy objective in awarding 1492-1517 MHz is to achieve optimal use of spectrum. This involves striking a balance between making the spectrum available for mobile use and ensuring that appropriate protections are in place for systems using adjacent frequency bands. To reach a view on the level of protection which is proportionate to implement around ports and airports in the UK, we have considered relevant factors, in particular:

a) the impact of protective requirements on mobile operators’ ability to provide services to citizens and consumers; and
b) the *impact* and *likelihood* of blocking to receivers on the maritime and aviation industries, taking into account:

    i) the relevant legal and operational context that underpins the maritime and aviation industries in the UK (which we have considered in further detail in Annexes A7 and A8);

ii) whether blocking poses a risk to safety of life in either an aviation or maritime context;
iii) the level of commercial disruption that potential blocking could cause to the aviation and maritime industries; and
iv) whether the potential blocking poses a risk to the UK's national security.

3.32 To aid our understanding of these issues (in particular, the actual impact of blocking to Inmarsat's receivers), we have sought further information from other regulators (the MCA and the CAA), an equipment manufacturer ([CONFIDENTIAL ✂]), industry bodies (e.g. [CONFIDENTIAL ✂]) and an airline ([CONFIDENTIAL ✂]).

Assessment of the appropriate protections to apply

Impact of protections on MNOs and consumers

3.33 We have outlined the benefits of MNOs having access to the spectrum in paragraphs 3.5-3.6 above.

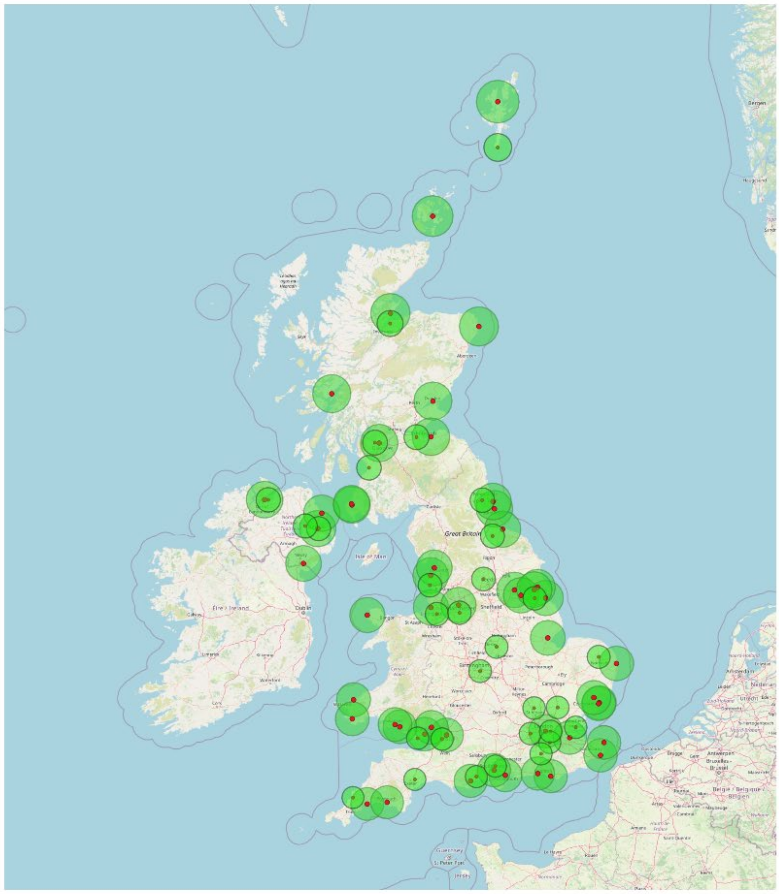
3.34 Protective requirements would require the MNOs to:

a) not deploy in the PFD-limited zones; and
b) ensure that each deployment in the coordination zones is designed to ensure that it does not cause the resulting PFD to exceed the limits in the PFD-limited zones.

3.35 These protections, particularly the Phase 1 protections, would amount to large coordination zones around ports and airports, which could significantly impact the MNOs' costs of deployment and the levels of coverage they would provide using this spectrum.

3.36 Figure 3.2 below illustrates the locations that would feature PFD limited and coordination zones, if we placed Phase 1 protective requirements around 51 major ports and the 32 international airports in the UK.

Figure 3.2: Locations of proposed Phase 1 PFD limited and coordination zones around major ports and international airports[13]



3.37 As outlined above, we consider that making 1492-1517 MHz available for terrestrial mobile networks could enable stronger connectivity for consumers, particularly in areas where there is currently limited coverage.[14] We consider the benefits in paragraphs 3.5-3.6 of mobile operators having unrestricted access to this spectrum would be passed on to consumers, through improved quality of service.

3.38 However, we also recognise that disruption and delays to commercial flights and the shipping industry as a result of blocking could have an adverse effect on consumers. In the sub-section below, we set out more detail of our understanding of the potential adverse

[13] Note that in Section 5, we set out four options for defining coordination zones. This diagram shows how these coordination zones would look under Option 2, where they are defined as circles around the PFD limited zones.

[14] As explained in our equality impact assessment in Annex A5, use of the upper 1.4 GHz block may bring particularly positive benefits for groups of people living in areas that may be more likely to benefit from the additional coverage that the upper 1.4 GHz spectrum can provide (e.g. rural areas). Our equality impact assessment also recognises that groups of people living in areas in which we impose protections (and therefore restrictions on the use of mobile) may not benefit from this additional spectrum in the same way as people living in similar areas that are not subject to restrictions.

effects of blocking. Following that, we outline our understanding of the likelihood of such blocking arising in practice for (a) the maritime industry; and (b) the aviation industry.

Likely impact of blocking to receivers

3.39 Below, we assess the potential impact and likelihood of blocking to Inmarsat's MSS receivers on board maritime vessels and aircraft at and near ports and airports.

Maritime

3.40 We understand that Inmarsat C MSS terminals are used on maritime vessels to meet safety requirements, as well as for more general communications and other services. In this context, Inmarsat C terminals are referred to as Inmarsat Ship Earth Stations ("**SES**"). These terminals also incorporate an Enhanced Group Call ("**EGC**") service.

3.41 Internationally, there is a legal requirement on some maritime vessels (including passenger and cargo ships of a certain size) under the Safety of Life at Sea Convention ("**SOLAS**") to have an SES terminal installed if they are sailing into Sea Area A3 i.e. a significant number of miles from the coast, far beyond the reach of any IMT signal.[15]

3.42 These SES terminals must receive their satellite service from an approved Global Maritime Distress and Safety System ("**GMDSS**") service. At the moment, there are two approved GMDSS MSS providers: Inmarsat and Iridium. However, Iridium was only formally authorised to provide GMDSS MSS in 2020 and its coverage of Maritime Safety Information ("**MSI**") is being rolled out across the globe in phases. While its coverage has improved significantly since 2020, it is still not global.[16] Many vessels subject to SOLAS therefore use an Inmarsat C terminal to meet these safety requirements.

3.43 The legal requirements that apply to vessels not subject to SOLAS depend on various factors including the type of vessel and relevant national rules of the flag state. Under UK rules, we understand that Inmarsat SES terminals are primarily required, or relied upon, to comply with relevant safety requirements on larger fishing vessels, high speed craft on international voyages and large commercial yachts used for sport and pleasure that travel into Sea Area A3.[17]

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[15] Sea Area A1 means an area within the radiotelephone coverage of at least one VHF coast station in which continuous Digital Selective Calling ("DSC") alerting is available, as may be defined by a Contracting Government. Sea Area A2 means an area, excluding Sea Area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government. Sea Area A3 means an area, excluding Sea Areas A1 and A2, within the coverage of an Inmarsat geostationary satellite in which continuous alerting is available. Sea Area A4 means an area outside Sea Areas A1, A2, and A3 (SOLAS IV, Reg 2, paragraphs 12-15).

[16] We understand that, while Iridium's network is global, it still does not have global MSI coverage as there is a phased implementation process across each NAVAREA and METAREA. However, it does have MSI coverage across the majority of the globe, including all European waters. The current implementation status of these NAVAREAs and METAREAs has been made available by the International Hydrographic Organisation.

[17] While SOLAS accepts any ship earth station that provides a recognised MSS, UK requirements can specify that if a ship earth station is used, it should be an Inmarsat C.

3.44 For a significant number of vessels, there is no safety requirement or recommendation to install a ship earth station as they do not travel far enough out to sea, although some vessels may have still chosen to install one for safety or non-safety purposes.[18]

3.45 While Inmarsat also provides FleetPhone and FleetBroadband services, we have identified no safety or operational requirements for these services.

3.46 We are also aware of the use of Maritime Autonomous Surface Ships ("**MASS**"), which are uncrewed and may rely on MSS for their operation.

3.47 In the paragraphs below, we summarise our understanding of the main issues which could arise if vessels' satellite receivers are blocked while at or near port. We then present two alternative options for the type of ports we may decide to protect. We also explain why we do not provisionally consider it appropriate to protect a longer list of ports or the entire UK coastline.

Requirements on maritime vessels at port

3.48 Satellite receivers on maritime vessels will not suffer blocking once they are away from coastal areas. However, we have identified two main issues which could arise if vessels' satellite receivers are blocked while at or near port:

a) **Testing at port:** Maritime vessels are required to check that their GMDSS communications work and in some circumstances, they may be required to carry out this check before they leave port. For example, there is a legal requirement for vessels subject to SOLAS to be surveyed at least annually, which includes an inspection of Inmarsat SES "for correct operation by inspection of recent hard copy or by test call" before they leave port.[19] Our understanding is that a "recent hard copy" is evidence that the vessel recently received a maritime safety information update.[20] More generally, we understand that ships may be subject to inspections by port state control[21] or the relevant flag state and in certain circumstances, testing of SES equipment at port may be the only means to pass an inspection or comply with another requirement. Testing of SES equipment at port may also be part of a ship's routine operational procedures.

b) **Receipt of maritime safety information ("MSI") (e.g. weather warnings) at and near port:** MSI is communicated to vessels over different systems, such as very high frequency ("**VHF**"), medium frequency ("**MF**") and MSS.[22] Each system covers different sea areas, so the MSI broadcast on each system will only cover the sea areas that it

[18] A ship earth station may also be required closer to shore where NAVTEX is not available. More detail on the relevant legal and operational requirements for ships can be found in Annex A7.
[19] For example, IMO Resolution A.1104(29), sections 4.1.2.12, 4.2.2.1 and 4.3.2.1; and ECC Report 299, section 3.2.3.
[20] IMO, Resolution A.1104(29)
[21] See IMO on Port State Control and MCA Guidance on Port State Control Expanded Inspections.
[22] While UK MSI is made available by the UK Hydrographic Office on its website, legally the only trusted source is the official broadcast. The UKHO advises that it "is not intended to be a substitute for, or an alternative to, the International Enhanced Group Call (EGC) Services or the International NAVTEX service, and does not relieve Masters/Captains of their responsibility to monitor MSI broadcasts in accordance with the provisions of SOLAS."

services. Additionally, MSI broadcasts are split into different geographic areas, which are broadcast at 12-hour intervals. This means that:

i) Maritime vessels travelling to Sea Areas A3 and A4 would only (legally) receive MSI updates from an MSS as these updates would not be broadcast on VHF or MF. This means that they need to receive MSS updates when they are at port and in Sea Areas A1 and A2 in order to plan their route accordingly for when they enter Sea Areas A3 and A4.
ii) If a maritime vessel's receiver is blocked at the time of a relevant MSI broadcast, it will be another 12 hours until it is able to receive the next update.

3.49 In addition to GMDSS, we understand that MSS is used for various other functions, such as Long Range Identification and Tracking ("**LRIT**"), ship security alert systems ("**SSAS**"), fishing vessel monitoring systems and more general requirements which are conducted via email, requiring the internet access provided by MSS. Blocking of Inmarsat MSS receivers could potentially cause some disruption for vessels (primarily foreign vessels), if their flag state requires certain systems (such as LRIT) to function at port and those systems rely on Inmarsat MSS. However, we understand that most systems that may rely on Inmarsat MSS are either used primarily at sea, or that there are other ways to meet the relevant requirements when at port, such as IMT.

3.50 None of the above appears to present a safety of life concern, other than in unlikely circumstances (e.g. a vessel leaves port without access to MSI and then sails into bad weather without forewarning). Nevertheless, our provisional view is that making this spectrum available for IMT use without protection at ports could cause significant disruption at ports across the country, depending how resilient affected receivers are to blocking from IMT use. For example, disruption could arise if multiple vessels are unable to receive MSI or if their Inmarsat C terminal fails a test call, as this could cause them to become stuck at port, blocking other vessels from docking. It may also mean a vessel is restricted to travelling closer to shore, i.e. in Sea Areas A1 and A2.

3.51 As we have not identified any safety or operational requirements for Inmarsat's FleetPhone and FleetBroadband services, it is our understanding that if they are blocked at port, it is unlikely to cause disruption. As such, we do not consider that they require protection measures. We do, however, note that they are likely to be protected by any protection measures that we propose for Inmarsat C receivers.

3.52 We have not identified any safety or operational requirements relevant to MASS which are not also applicable to other maritime vessels.

3.53 In the paragraphs below, we consider which type of ports are most likely to be affected by potential disruption.

Types of ports that may be impacted by blocking

3.54 The Department for Transport ("**DfT**") publishes an annual dataset titled "All UK major and minor port freight tonnage traffic."[23] We understand this dataset identifies the main commercial ports in the UK, as well as commercial fishing and ferry ports, which we understand are the types of ports most likely to be used by maritime vessels that use MSS. There are a significant number of ports (160) identified in the DfT list. For the reasons set out in Annex A7, we provisionally consider the DfT dataset identifies the main ports where maritime vessels may be impacted by blocking and we do not believe protecting any longer list of ports will enable us to achieve our objectives.

3.55 While all 160 ports in the DfT's dataset may potentially be used by vessels which use Inmarsat MSS, we note that MSS is generally only required on larger vessels that travel further out to sea and those vessels are likely to use larger ports.[24]

3.56 In Annex A7, we discuss two alternative options for the type of ports we could protect:

a) all 51 major ports in the DfT's dataset; or
b) all 160 major and minor ports in the DfT's dataset.

3.57 We also explain our provisional view that it would not be appropriate to protect a longer list of ports or the entire UK coastline.

3.58 Our provisional understanding is that maritime vessels using the minor ports on the DfT's list may not travel as far out to sea and may therefore be less likely to rely on Inmarsat MSS terminals. As a result, our provisional view is that protecting only the 51 major ports on the DfT's list should ensure that any impact of blocking to MSS terminals does not cause disruption. We welcome stakeholders feedback on all of the options we have considered.

Aviation

3.59 MSS receivers on board aircraft should not suffer blocking in the air. However, we have identified the following potential operational difficulties which aircraft may encounter if they suffer blocking to their MSS while they are on the ground.[25]

3.60 As we have not identified any safety or operational requirements for Inmarsat's SwiftBroadband services, it is our understanding that if they are blocked at airports, it is unlikely to cause disruption. As such, we do not consider that they require protection measures. We do, however, note that they are likely to be protected by any protection measures that we propose for Classic Aero receivers.

FANS 1/A

3.61 1.5 GHz MSS has been incorporated into the Future Air Navigation System ("**FANS 1/A**") to provide direct data link communications between the aircraft and Air Traffic Control. This system, together with satellite voice communications, allows for the safe separation of

[23] Department for Transport, Port freight annual statistics 2023, spreadsheet titled PORT0101. The tab which identifies traffic in both directions lists 53 major ports at the top and a further 109 minor points underneath, totalling 160 major and minor ports. We have removed two major ports from the count on the understanding that they have since been closed.
[24] More detail on the types of vessel and the relevant legislation can be found in Annex A7.
[25] More detail on the relevant legal and operational requirements for aircraft can be found in Annex A7.

aircraft in oceanic and remote airspace when out of range of terrestrial surveillance and terrestrial data and voice communications.

3.62 In the North Atlantic region (used for flights from Europe to/from North America), guidance issued by the International Civil Aviation Organization ("**ICAO**") states that aircraft should have FANS 1/A capability if they wish to use the preferred aircraft tracks and altitudes above 29,000 ft in the North Atlantic Region. According to these procedures, "If a flight experiences an equipment failure prior to departure which renders the aircraft non-DLM (Data Link Mandate) compliant, the flight should re-submit a flight plan so as to remain clear of the NAT DLM airspace". Aircraft without FANS 1/A capability would have to use alternative tracks and altitudes, which might require additional fuel burn.[26]

3.63 We understand that if an aircraft intending to use a FANS 1/A route fails a pre-departure test of its MSS, it would have to re-route to a route which is likely to require more fuel. This could cause significant delays at international airports. As well as impacting passengers, delays may impact staff shift patterns and generally increase costs for the airline industry.[27]

Project Iris

3.64 Project Iris has been designed to improve air traffic management over continental and transoceanic airspace. In the context of Iris, we understand that new terminals for aircraft should meet new standards and new blocking requirements that should be resilient at Phase 2 level restrictions.[28]

3.65 Although Project Iris is not yet mandated in the same way as FANS 1/A, we understand this may change in the future, and that blocking could therefore cause the same level of disruption to flights operating in the European airspace.

Domestic and private airports

3.66 We understand that MSS is less likely to be required for domestic flights as they do not require FANS 1/A capability.[29]

3.67 Our understanding is that MSS may be used for international flights from private airports, and so blocking at private airports could cause some limited disruption for the reasons set

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[26] ECC Report 299, s.3.1.

[27] See, for example, section 3.1 of ECC Report 299 which states: "The [Minimum Equipment List] for one of Europe's largest airlines states that loss of Satcom means that … [equipment] (used for safety of flight communications … in regards to safe separation of aircraft) cannot be used … meaning that aircraft flying the North Atlantic at a minimum would need to carry more fuel (or less cargo/passengers) since such an aircraft is not allowed to enter the airspace defined under the NAT data link mandate. Thus, while the potential blocking of MSS … does not pose a direct threat to safety of flight in the vicinity of airports, it may result in the disruption of departures, delays and cost overruns for airlines."

[28] We note that ICAO has encouraged the aeronautical industry to improve the resilience of aeronautical L-band Mobile Earth Stations ("MES") receivers to tolerate a -30 dBm blocking level for MES operating above 1520 MHz, noting that this blocking level has been taken as the reference in Europe for putting in place less stringent protection measures for resilient L-band MES (ICAO Information Note). Furthermore, other international administrations have indicated that they will transition to Phase 2 limits within the next few years. SDFI (the Danish regulator) has set 1st January 2025 (SDFI, HØRINGSNOTAT, p. 17) and BMF (the Austrian administration) has set 1st January 2028 (RTR, Anlage zum Bescheid F 1/16-394 der Telekom-Control-Kommission vom 19.10.2020, p. 7).

[29] [CONFIDENTIAL ✂].

out above. However, private airports are a lot smaller than commercial airports, and they cater to fewer people,[30] so our provisional view is that any disruption will be more limited.[31]

Uncrewed aerial vehicles ("UAVs")

3.68 Our understanding is that UAVs are uncrewed and may use Inmarsat MSS for their operation. Even if they do use Inmarsat MSS, we note that UAVs:

a) Are unlikely to fly transatlantic routes and be subject to FANS 1/A. If they do fly such routes, our expectation is that they will do so from either international airports or MOD sites,[32] or will do so from a domestic or private airport.[33]
b) May take off from a wide range of places around the UK, meaning that their location and other technical parameters are subject to constant change. This means that protecting them is unlikely to be feasible without sterilising significant portions of the UK landmass. However, given the flexibility with which they may be used, it is possible for users to move to another location should they encounter an issue.

3.69 Our provisional view is that any potential disruption to UAV use would be more limited than for international flights from commercial airports and protecting UAV would not enable us to achieve our objectives.[34]

Likelihood of blocking to receivers

3.70 Given the analysis set out above that blocking of MSS receivers at and near ports and airports could cause disruption, below we set out our understanding of the resilience of Inmarsat's receivers to blocking from use of IMT in the adjacent band, which we consider is important for understanding the likelihood of blocking arising in practice. Our understanding of the resilience of Inmarsat's receivers comes from (i) analysis carried out by CEPT, and published in ECC Report 299, and (ii) Viasat's response of 11 September 2024 to a request for information we issued on 7 August 2024 using our statutory information gathering powers.

3.71 It is also useful to note evidence from Japan, where 1475.9-1510.9 MHz has been available for mobile use since 2012, and where operators have so far deployed this spectrum on at least 50,000 base stations.[35]

ECC analysis

3.72 ECC Report 299, published in 2019, includes some detail of measurements of the resilience of Inmarsat's receivers. This includes measurements indicating that Model 3 Inmarsat C terminals, which constitute 48% (77,000) of all terminals in circulation, are resilient to

[30] See for example CAA, Annual airport data 2023, Table 1.
[31] In some circumstances, VHF may also be a viable alternative to the use of MSS at smaller airports where there is less risk of VHF congestion.
[32] In which case our analysis in paragraphs 3.61-3.65 and 3.81 and proposals paragraphs 3.84-3.90 apply.
[33] In which case our proposal at paragraph 3.67 applies.
[34] We also consider that our provisional view on land terminals, set out in paragraphs 4.23-4.32 applies to UAVs.
[35] Paragraphs 3.82-3.83.

blocking provided that Phase 2 protections are in place.[36] However, we note that ECC Report 299:

a) Provides measurement results for only three models of Inmarsat C maritime terminals, which it has anonymised. Viasat has subsequently confirmed that there are over 100 [CONFIDENTIAL ✂] Inmarsat C models currently in circulation.[37]
b) Identifies eight models of Inmarsat aero terminals, all of which are anonymised, and only provides measurement results for two of these terminals: one Classic Aero terminal and one SwiftBroadband. Viasat has subsequently confirmed that there are several hundred aero terminal models, more than half of which are in circulation, and the vast majority of these models [CONFIDENTIAL ✂] are Classic Aero terminals.[38]
c) Provides data on the number of maritime terminals in circulation but does not provide the same information for aircraft terminals.
d) Is more than five years old.

Our understanding of the current terminals in circulation

3.73 As noted above, ECC Report 299 was published in 2019 and so the information regarding numbers of Inmarsat terminals in circulation is now over five years old. We therefore requested updated data from Viasat. In response to a statutory information request sent on 7 August 2024, Viasat provided us with the most up to date information it holds on:

a) the model types available;
b) the number of each type of model in circulation; and
c) the resilience of these models to blocking from IMT use in the 1.4 GHz band, where available.

Maritime

3.74 Viasat provided all data it holds relating to measurements conducted on its Inmarsat maritime terminals to establish their likely resilience to blocking from adjacent band IMT use. Viasat identified over 100 [CONFIDENTIAL ✂] *models* of Inmarsat C in circulation, and approximately 125,000-130,000 Inmarsat C *terminals*. It holds data on the resilience of [CONFIDENTIAL ✂] of the models in circulation, which amounts to around 25% of all terminals in circulation.[39]

3.75 Our analysis of this data suggests that [CONFIDENTIAL ✂] models require Phase 1 protections. It also suggests that, of the Inmarsat C terminals currently in circulation for which Viasat holds resilience data:

[36] ECC report 299, table 6, Inmarsat C Model 3.
[37] We note that, of these over 100 Inmarsat C models, no model type comes close to having 77,000 terminals in circulation, nor constituting 48% of total models in circulation. Therefore, we consider that it is likely that this total is an extrapolation of multiple (untested) terminal models and may not be accurate.
[38] Ofcom analysis of: Viasat, Information request - September response, Terminal Model Spreadsheet, Aeronautical tab'; Viasat, Confidentiality response, p. 27, table 2.
[39] Ofcom analysis of: Viasat, Information request - September response, Terminal Model Spreadsheet, Maritime tab; Viasat, Information request - September response, Maritime Q1a file. Viasat, Confidentiality response, p. 21, table 2.

a) roughly half require Phase 1 protections;[40] and
b) roughly half are already resilient to blocking at or around Phase 2 protection levels.[41]

3.76 As a result, we have considered how long any receivers which are susceptible to interference might remain in use, if users are not encouraged or required to upgrade them. We do not have conclusive data on this, however:

a) ECC Report 299 states that the natural lifespan of a terminal is 20-30 years,[42] meaning that any terminals which do not meet Phase 2 requirements could be in circulation for up to 30 more years if users are not encouraged or required to upgrade them within a shorter timeframe.
b) Our analysis of Viasat's data shows that [CONFIDENTIAL ✂]. We therefore understand that approximately a third of terminals would remain in circulation for between 5 and 15 years, at most.[43]
c) [CONFIDENTIAL ✂] [44]. As a result, our understanding is that some terminals that have been available for over 10 years are unlikely to require upgrading.[45]

Aviation

3.77 As noted above, Viasat has identified several hundred [CONFIDENTIAL ✂] aircraft terminal models. More than half [CONFIDENTIAL ✂] of these are in circulation, and the majority [CONFIDENTIAL ✂] of those models in circulation are Classic Aero terminals. There are approximately 12,000-13,000 Classic Aero terminals in circulation.[46]

3.78 We have not been able to obtain data on the level of resilience of the Inmarsat terminals which are installed on aircraft.[47] [CONFIDENTIAL ✂].[48]

3.79 However, our analysis of the data Viasat was able to provide (which has not been confirmed by Viasat) suggests that a significant proportion of aircraft terminals currently in circulation are made by Honeywell and Cobham, which have developed updated Diplexer/Low Noise Amplifier ("**DLNA**") modules to allow many of their satellite terminals to operate in the presence of IMT transmissions in the adjacent band.[49] We therefore understand that it is possible to upgrade the DLNA module on these terminals without modification to the fuselage. Doing so would improve receivers' resilience, such that they are unlikely to be

[40] This means that at least [CONFIDENTIAL ✂]% (but potentially many more) of the Inmarsat C terminals currently in circulation require Phase 1 protections.
[41] This means that at least [CONFIDENTIAL ✂]% (and potentially many more) of the Inmarsat C terminals currently in circulation are resilient to blocking at or around Phase 2 protection levels.
[42] ECC Report 299, p. 19, 4.3: Lifetime of Equipment on Board Vessels.
[43] Ofcom analysis of: Viasat, Information request - September response, Terminal Model Spreadsheet, Maritime tab. Viasat, Confidentiality response, p. 35, table 2.
[44] [CONFIDENTIAL ✂]
[45] [CONFIDENTIAL ✂] Ofcom, letter of 25 January 2025 regarding confidentiality, p. 3.
[46] Ofcom analysis of: Viasat, Information request - September response, Aeronautical tab; Viasat, website, Classic Aero.
[47] We understand that there are approximately one dozen manufacturers that produce several hundred unique Inmarsat aviation terminal models. Consequently, data on the level of resilience of each terminal is not centralised with any one party ([CONFIDENTIAL ✂]).
[48] Ofcom analysis of: Viasat, Information request - September response, Aeronautical - Q1a file.
[49] Ofcom analysis of: Viasat, Information request - September response, Aeronautical - Q1a file; Viasat, Information request - September response, Terminal Model Spreadsheet, Aeronautical tab.

susceptible to mobile interference if Phase 2 protections are in place. We do not know how many terminals may already be fitted with this equipment.

3.80 We have also considered how long any aircraft receivers which may be susceptible to interference might remain in use, if users are not encouraged or required to upgrade them. We do not have conclusive data on this, however:

a) ECC Report 299 states that the natural lifespan of a terminal is 20-30 years,[50] meaning that any terminals which do not meet Phase 2 requirements could be in circulation for up to 30 more years if users are not encouraged or required to upgrade them within a shorter timeframe; and
b) Our analysis of data provided by Viasat suggests that [CONFIDENTIAL ✂].[51] We therefore understand that approximately half of terminals would remain in circulation for between 5 and 15 years, at most.

Ministry of Defence

3.81 We understand from the Ministry of Defence ("**MOD**") that it uses Inmarsat terminals on some military vessels and aircraft, and, based on our analysis, a number of these terminals would require Phase 1 protections. Blocking to MSS at particular locations could therefore pose an operational risk to MOD activity and impact the UK's national security.

International experience

3.82 We understand that spectrum in the range 1492 – 1517 MHz has so far been made available for mobile use in a number of European countries, as well as in Japan. The information we have shows that of these countries, only Denmark and Japan have made available spectrum in this range without any restrictions around ports.

3.83 We understand that operators have not yet deployed this spectrum in Denmark. In Japan, the range 1475.9 - 1510.9 MHz has been licenced for mobile use since 2012.[52] As of March 2020, operators had deployed this spectrum on over 50,000 base stations, approximately 30,000 of which were transmitting in the range 1495.9 – 1510.9 MHz. We are currently not aware of any evidence that these deployments have resulted in disruption to the use of MSS terminals at Japanese ports. This suggests that the assumptions made in the studies carried out by CEPT, and in setting up the measurements underlying the test data we have from Inmarsat, could be overly conservative, and that the risk of blocking could in practice be very limited. However, considering the limited information we currently have about the circumstances, we do not propose placing weight on the experience in Japan at this stage. We welcome any evidence or comments from stakeholders about the deployment of this spectrum and/or use of Inmarsat's MSS services in Japan.

[50] ECC Report 299, p. 19, 4.3: Lifetime of Equipment on Board Aircraft.
[51] Ofcom analysis of: Viasat, Information request - September response, Terminal Model Spreadsheet, Aeronautical tab.
[52] This information is from the presentation "Use of L-band for IMT in Japan" by NTT Docomo. See slide 5 for dates when frequencies were authorised, as well as the number of base stations using the frequencies. [CONFIDENTIAL ✂]

Our revised proposals

Protection around ports and airports

3.84 As explained above, our primary policy objective in awarding 1492-1517 MHz is to achieve optimal use of spectrum. This involves striking a balance between making the spectrum available for IMT use and ensuring that appropriate protections are in place for systems using adjacent frequency bands.

3.85 We recognise that allowing mobile operators unrestricted access to this spectrum should enable stronger connectivity and improved IMT services for consumers, particularly in areas where there is currently limited coverage. But it is also likely to cause blocking to some MSS terminals in the adjacent 1.5 GHz band. We have assessed the potential impact and likelihood of this blocking and understand that of the Inmarsat C terminals currently in circulation for which Viasat holds resilience data roughly half [CONFIDENTIAL ✂]% would be likely to suffer from harmful blocking from IMT without Phase 1 protections. We do not have data on the level of resilience of the Inmarsat terminals which are installed on aircraft.[53] As a result, we consider it necessary to take a cautious approach to protections around aircraft, assuming a significant number of terminals on aircraft may have receivers which could suffer blocking.

3.86 As a result, our provisional view is that:

a) blocking could affect a significant number of maritime vessels and aircraft; and
b) blocking could cause significant disruption at ports and international airports, which we consider would have a negative impact on the maritime and aviation industries,[54] and ultimately on the UK's citizens and consumers.

3.87 Taking into account our relevant legal duties, and for the reasons set out above, we propose to implement Phase 1 protections around certain ports and airports when the spectrum is made available for IMT. Our provisional view is that not imposing Phase 1 restrictions around these ports and airports would risk a disproportionate impact on the maritime and aviation industries. We do not however consider Phase 1 restrictions to be appropriate to ensure optimal use of the spectrum in the longer term and we discuss how we intend to reduce these restrictions over time below.

3.88 Our provisional view is that these protections are only necessary around international commercial airports and either the major, or major and minor, ports identified in the Department for Transport's "All UK major and minor port freight tonnage traffic" dataset. A list of the ports and airports we propose to protect are listed in Annexes A7 (paragraph A7.62) and A8 (at paragraph A8.34).

[53] [CONFIDENTIAL ✂]

[54] As explained in our Equality Impact Assessment in Annex A5, it is also possible that our proposals may have an adverse impact on some equality groups to the extent they may be more likely to utilise affected Inmarsat equipment on ships and aircraft in the adjacent band. We also identify the steps we intend to take to help mitigate the impact on users of the adjacent band.

3.89 Recognising that MSS is used by the MOD in maintaining the UK's national security, we also propose to implement coordination and PFD limited zones around specific MOD uses. This is likely to amount to restrictions at Phase 1 levels around approximately 10 military air bases. We will continue to work with the MOD to assess if and when these restrictions can be reduced to Phase 2 levels.

3.90 We expect that the general restrictions that we are proposing around relevant ports will also be adequate to protect MOD maritime uses.

Reducing restrictions from Phase 1 to Phase 2

3.91 As set out above, Inmarsat's receivers operate in an adjacent band to the spectrum we are proposing to award, and the risk of blocking to these receivers stems from the fact that some of them do not adequately filter out transmissions from frequencies they should not be sensitive to. As set out in our Spectrum Strategy,[55] we would not usually expect to put in place measures to protect them; rather, we would expect Inmarsat to ensure that receivers used in their network are suitably resilient to blocking from any adjacent band spectrum uses. We recognise that, in practice, it is likely that terminal users will bear the upgrade cost rather than Inmarsat (or its parent company Viasat) or the terminal manufacturers.

3.92 This band was first identified for IMT use in 2015, meaning the satellite industry has had nearly ten years to ensure these receivers are suitably resilient, for example by:

a) conducting testing to identify which terminals in circulation contain receivers that would meet Phase 2 restrictions and which would not;
b) ceasing production of terminals which do not contain receivers that meet Phase 2 requirements, and instead encouraging production of terminals with resilient receivers;
c) focussing on producing filters that can be added to current less resilient receivers to improve their resilience to blocking; and
d) communicating with users about the issue and the future risks.

3.93 In reality, we have seen little engagement from the industry on developing solutions to this issue.

3.94 It remains important to ensure that this spectrum can be used more efficiently as quickly as possible, and so we propose to set an end date for the significant protections we have proposed. This will help us achieve our objectives, in particular by:

a) providing an incentive for the satellite industry to move to better performing receivers; and
b) making more spectrum available for IMT use, improving capacity and quality of service for consumers.

3.95 To help us set a date for reducing restrictions to Phase 2 levels, we have considered whether we should carry out testing of the resilience of Inmarsat's receivers to plug the gaps in Viasat's own data and identify which models of receivers need to be upgraded. This might in theory enable us to better understand the scale of the issue and allow the

[55] Ofcom, Supporting the UK's wireless future: Our spectrum management strategy for the 2020s, para. 3.66.

maritime and aviation industries to identify precisely which maritime vessels and aircraft need to be upgraded.

3.96 However, any testing we carry out is likely to require the use of live satellite signals and we do not believe we would be able to carry out testing in a controlled environment in a way that would produce conclusive results we could rely on to make decisions in relation to the award of the 1.4 GHz band.[56] We consider Inmarsat and/or equipment manufacturers have the capability, and are best placed, to test the resilience of the receivers that use Inmarsat's services and subsequently notify affected users.

3.97 We also do not consider it necessary for this testing to be carried out in order for us to decide on an appropriate transition period to move to Phase 2. Below, we discuss two alternative options for this transition period for both the maritime and aviation industries which take into account comments received in response to the CFI as well as subsequent discussions with stakeholders:

a) **Option A**: An accelerated upgrade process over a relatively short Phase 1 period, around five years from the date of our final decision. In order to avoid the risk of blocking once restrictions are relaxed to Phase 2 levels, we would expect maritime vessel operators and airlines to upgrade the Inmarsat receivers most at risk within the specified period; or
b) **Option B**: A natural retirement and upgrade process, taking up to 20 years to transition from Phase 1 to Phase 2 restrictions, starting from the date of our final decision. In order to avoid the risk of blocking, we would expect maritime vessel operators and airlines to upgrade the Inmarsat receivers most at risk from blocking within the specified period, most likely at the point that the affected terminal would naturally be retired.

3.98 We have explained the rationale for both options in Annex A7 (for the maritime industry) and Annex A8 (for the aviation industry) and our preference would be for an accelerated upgrade process, around five years from our final decision, after which we would reduce restrictions on IMT use of this spectrum to those required at Phase 2. This is because we consider a short transitional period is more likely than a longer period to achieve our objectives and strike an appropriate balance between (i) allowing the maritime and aviation industries sufficient time to upgrade their equipment (where necessary), and (ii) ensuring the efficient use of the spectrum (i.e. reducing restrictions on IMT use as soon as practical). As explained in our Impact Assessment,[57] we expect that the incremental cost that a quicker move to Phase 2 would impose on the maritime and aviation industries is likely to be low. Overall, we provisionally consider that the benefits of making the spectrum available for IMT sooner under Option A outweigh any potential adverse impacts on the maritime and aviation industries.

3.99 We welcome stakeholders feedback on both options and in particular:

a) Any evidence that a shorter period, around five years, for the relevant receivers to be replaced or upgraded is not technically or practically feasible.

[56] In this regard, we note that [CONFIDENTIAL ✂].
[57] Annex A5, paras. 5.34-5.45 and 5.47-5.48.

b) The impact that a longer period of up to 20 years may have on the ability of MNOs to use the spectrum and the benefits to consumers and citizens that would be foregone.

3.100 In this regard, we note that comments based on hypothetical or potential scenarios are less helpful and less reliable than comments based on evidence or objective facts, particularly in the context of justifying significant restrictions on IMT for a longer period.

Consultation questions

Question 1: Do you agree with our proposal that 'Phase 1' protections would be required to avoid the potential for significant disruption at ports and airports?

Question 2: Do you agree with the list of airports we propose to protect, in Annex A8?

Question 3: Do you have any comments on the two options we have proposed for the ports which would require protection, noting the further detail (and requests for specific evidence) in Annex A7?

Question 4: Do you agree with our preference to reduce these restrictions to 'Phase 2' levels over a shorter timeline than the natural lifecycle of the terminals?

Question 5: Taking into account the further detail in Annexes A7 and A8, please provide any evidence:

- that a shorter period, around five years, for the relevant receivers to be replaced or upgraded is not technically or practically feasible; or
- of the impact that a longer period of up to 20 years may have on the ability of MNOs to use the spectrum and the benefits to consumers and citizens that would be foregone.

4. Protection of other adjacent band users

Summary

4.1 In addition to satellite receivers on maritime vessels and aircraft (discussed in Section 3), the adjacent 1.5 GHz band is used for the operation mobile satellite services ("**MSS**", also known as Satcom) on land terminals and for programme making and special events ("**PMSE**"). It has also been identified for future uses by Viasat.

4.2 We do not propose to include specific protection measures for land terminals, PMSE, or future uses of the 1.5 GHz band.

Uses

Land terminals and inland use of maritime terminals

4.3 The 1.5 GHz band is currently used by Inmarsat on a licence exempt basis to operate MSS terminals on land. Existing Inmarsat satellite receivers, especially older models, are susceptible to blocking from IMT transmissions at frequencies below 1518 GHz across their full receive range (1518-1559 MHz). This means that some land terminals may be susceptible to blocking from use in the upper block of the 1.4 GHz band (1492-1517 MHz), which we are proposing to make available for IMT use.

4.4 Land terminals can be both portable and fixed, and are important where telecommunications redundancy and security is needed. A few example uses include Internet of Things ("**IoT**") modules for telemetry, logistics, and safety compliance; [58] infrastructure protection[59] and remote worker safety;[60] and enabling communications for first responders and military users in emergencies. Other applications involve rail signalling, agricultural connectivity, and live media broadcasting.[61]

[58] Viasat, 2 April 2024 response to Ofcom's March 2024 statutory information request ("**Information request - April response**"), L-Band Terminal Summary, land tab, B5; Viasat, Response to Ofcom regarding confidentiality of 22 January 2025 ("**Confidentiality response**"), p. 16, table 2.
[59] Viasat, CFI response, p. 3, Q. 1; Viasat, Information request - April response, L-Band Terminal Summary, land tab, B5; Viasat, Confidentiality response, p. 16, table 2.
[60] Viasat, Information request - April response, L-Band Terminal Summary, land tab, B5; Viasat, Confidentiality response, p. 16, table 2.
[61] Viasat, Information request - April response, L-Band Terminal Summary, land tab, B3; Viasat, Confidentiality response, p. 16, table 2.

4.5 Inmarsat C maritime terminals are also used by maritime vessels on inland waterways[62] and at a small number of fixed locations on land.[63]

4.6 We have not identified any safety or operational requirements for the use of Inmarsat's MSS land terminals, or for the use of its maritime terminals inland. For the uses we are aware of, we understand there are alternative means of communications available.

Future services

4.7 Potential future services which may use the 1.5 GHz band include:

a) direct-to-device ("**D2D**") services;[64]
b) a telemetry relay service for rockets;
c) commercial uncrewed aviation; and
d) an MSS R&D site at [CONFIDENTIAL ✂].[65]

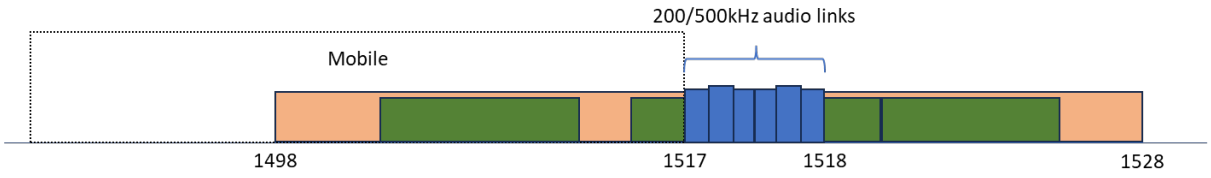
PMSE

4.8 There are two allocations for PMSE which overlap with or are adjacent to the 1.4 GHz band:

a) 1517.25-1517.75 MHz is allocated for audio links; and
b) 1-2 GHz is allocated for telemetry links, used for motor racing.

4.9 Audio Links are temporary fixed point to point links, used, for example, for taking output from a studio to a transmitter, or a remote studio to the main studio. Generally, telemetry links require larger bandwidths (around 8 MHz) than audio links (which require up to 500 KHz).

Figure 4.1: PMSE uses of the 1.4 and 1.5 GHz band (blue blocks show audio links and green blocks show telemetry links, the widest (tan) block from 1498-1528 MHz shows an F1 telemetry link licenced in this band)



CFI proposal

4.10 In the October 2023 call for input ("**CFI**"), we stated our intention not to implement protection measures for land terminals on the basis that their portability makes their location and other technical parameters subject to constant change.

[62] Viasat, CFI response, p. 6, Q. 1.
[63] MCA, meeting note of 7 November 2024, para 1.6; MCA, Response to Ofcom regarding confidentiality of 20 December 2024 ("**Confidentiality response**"), p. 1.
[64] Viasat, CFI response, p. 3-5, Q. 1.
[65] Viasat, Information request - April response, L-Band Terminal Summary, land tab, F7;

4.11 We did not make any proposals relating to protections for PMSE or future users of the band.

Stakeholder comments

Land terminals and inland use of maritime terminals

4.12 Viasat said that we should protect land terminals. Its response provided a high-level explanation of what such terminals are used for, alongside reasoning to support protecting them.

4.13 Viasat advised that land terminals "play a crucial role in safeguarding critical infrastructure and other national interests and are used nationwide by military and security services to protect the United Kingdom, its leaders, and citizens". It also highlighted that land terminals are relied upon by numerous industries for day to day, emergency and backup operations.[66] It also said that Inmarsat's land terminals include low power devices such as "Internet of Things" ("**IoT**") modules[67] which enable telemetry, logistics, and safety compliance. It noted that land terminals are "particularly useful in areas where terrestrial networks are unavailable, specifically rural areas and stretches of road in areas away from population centres or where telecommunications redundancy and security is needed".[68]

4.14 It also rejected Ofcom's argument that it was not possible to protect land terminals because of their portability. It noted that land terminals can be both stationary and non-stationary, and that measures could be taken to protect both. It said that the known locations and operating parameters of stationary terminals could be used to establish protection zones, but that these would need to be reviewed and updated to ensure the protection of future terminals. It considered that non-stationary terminals could be protected by analysing usage patterns and establishing protection zones around relevant areas (e.g. "populations centres, roadways, rural industrial areas").[69]

4.15 To support its argument, Viasat provided usage pattern data for Broadband Global Area Network ("**BGAN**") and Global Satellite Phone Services ("**GSPS**") enabled devices. Viasat demonstrated the following use around the UK, and proposed that Ofcom should establish protection zones around these areas:

a) Vehicular BGAN: along some of the UK's longest or most remote roads, spanning across Wales, England and Scotland;
b) Portable BGAN: most of the Southeast of England as well as substantial amount of British coastline, including the near totality of the east coast; and
c) GSPS: across the country, but particularly along the east coast and waterways.[70]

[66] Viasat, CFI response, p. 3, Q. 1.
[67] Viasat, Information request - April response, L-Band Terminal Summary, land tab, B5; Viasat, Confidentiality response, p. 6, table 1.
[68] Viasat, Information request - April response, L-Band Terminal Summary, land tab, B3; Viasat, Confidentiality response, p. 7, table 1.
[69] Viasat, CFI response, p. 5, Q. 1.
[70] Viasat, Information request - April response, L-Band Terminal Summary, land tab, B3-B4; Viasat, Confidentiality response, p.64, table 2.

4.16 Viasat also suggested further protection measures for land terminals, including:

a) power limits to mobile network antennas to reduce their effective isotropic radiated power ("**EIRP**"), out of band emission ("**OOBE**") limits, and guard bands;[71]
b) limiting the use of the band to indoor only deployments.[72]

4.17 Viasat, the Maritime and Coastguard Agency ("**MCA**") and John Shaw advised that uninterrupted MSS communications must be maintained for maritime vessels navigating through inland waterways.[73]

4.18 The MCA added that "a small number of UK Global Maritime Distress and Safety System actors use land installations to monitor recognised MSS broadcasts as part of the UK's international obligations."[74]

Future services

4.19 Viasat noted that future Direct to Device ("**D2D**") satellite communications is a growth opportunity for satellite over the coming years, and will "integrate MSS services into standard mobile phones and unlocks the potential for massive Internet of Things ("IOT") automotive and defence applications".[75]

4.20 It also said that its services were "enabling new industries to take root in the United Kingdom". It highlighted its contract with the UK Space Agency and the European Space Agency for its "inRange" system, "a ground-breaking in-orbit telemetry relay service for rockets" which would support efforts for the UK to become "Europe's leading provider of small satellite launch by 2030," It also noted Velaris, a new L-band service for commercial uncrewed aviation.[76] Viasat suggested that if Ofcom did not protect land-based operations in the 1.5 GHz band, it would risk "foreclosing use of the band for future MSS services" [CONFIDENTIAL ✂].[77]

4.21 Viasat also highlighted a planned research and development centre in [CONFIDENTIAL ✂].[78]

PMSE

4.22 We did not receive any CFI responses relating to PMSE. However, since the CFI, we have engaged with several users of 1517-1518 MHz for PMSE services.

[71] Viasat, CFI response, p. 5, Q. 1.
[72] Viasat, CFI response, p. 10, Q. 4.
[73] Viasat, CFI response, p. 6, Q. 1; Shaw J, CFI response, p. 4, Q. 2; MCA, CFI response, p. 6, Q. 5; MCA, Confidentiality response, p. 1.
[74] MCA, meeting note of 7 November 2024, para 1.6; MCA, Confidentiality response, p. 1.
[75] Viasat, CFI response, p. 2, Q. 1.
[76] Viasat, CFI response, p. 4-5, Q. 1.
[77] Viasat, confidential CFI response, p. 2, Q. 1., Viasat, Confidentiality response, p. 60, table 2.
[78] Viasat, Information request - April response, L-Band Terminal Summary, land tab, F7; Viasat, Confidentiality response, p. 64-65, table 2.

Assessment of appropriate protections to apply

Land terminals and inland use of maritime terminals

4.23 It is possible that Inmarsat's land terminals (including land based maritime terminals) in areas where IMT systems are deployed without any restriction may suffer blocking. Our proposals could impose a cost on some users of land terminals (if they want to mitigate the risk of blocking). However, our provisional view is that those costs would likely be small compared to the benefits that would be lost by the restrictions we would have to place on IMT deployments to avoid them.[79] In particular, we have not identified any safety or operational requirements to use Inmarsat land terminals or potential for significant disruption that could be caused by blocking of land terminals (unlike the potential concerns identified in Section 3 which could result from disruption to MSS on ships and aircraft).

4.24 In reaching this provisional view, and as explained in more detail below, we have considered the risk of interference to land terminals; the potential impact on users of land terminals if that risk crystallises, including the ways they could mitigate the risk and impact of interference; and the impact of protecting land terminals from mobile use of the upper 1.4 GHz band. We also note that no other country that has made 1492-1517 MHz available for mobile has imposed restrictions on mobile use to protect land terminals.

Risk of interference

4.25 We note that a risk of interference to Inmarsat land terminals could only arise if: (i) land terminals are not suitably resilient to blocking from adjacent band mobile; and (ii) mobile operators roll out this spectrum in areas where those land terminals are used, in such a way as to cause interference to land terminals.

4.26 We do not have evidence of the resilience of land terminals and have no evidence that use of the upper 1.4 GHz block for mobile will in fact interfere with land terminals.[80] Our provisional view is that the risk of interference is also likely to be low, in particular because:

a) there are at least two dependencies that must occur for this risk to crystallise, as set out in paragraph 4.25;
b) Viasat has told us that land terminals primarily operate in very remote areas, which may not be a priority for mobile deployment of this spectrum;
c) we are not aware that interference to land terminals has been a problem in other countries where this spectrum has been made available; and
d) the protections that we have proposed around ports and airports will protect land terminals in the same areas.

[79] Satellite phone handsets costs range from £300-1500 (Satphone), and BGAN terminals range from £3000-13,000 (GTC).

[80] We are not aware of any studies examining the impact of blocking from mobile use in the 1.4 GHz band on land terminals. While we are aware of some land-based maritime terminals, we do not know what models these terminals are, and so cannot comment on their resilience.

Impact of interference

4.27 In its CFI response, Viasat said that its land terminals:

> *"play a crucial role in safeguarding critical infrastructure and other national interests and are used nationwide by military and security services to protect the United Kingdom, its leaders, and citizens. Numerous industries also rely on Viasat services for critical day-to-day, emergency, and backup operations. For example, utilities use Viasat's BGAN M2M service for efficient grid monitoring and control. … Scientists and emergency responders alike rely on Viasat's land-based satellite communications ("SatCom") for weather and environmental monitoring and continuity of services during natural and manmade disasters such as flooding and severe storms."*[81]

4.28 We have therefore sought further information about specific safety critical uses of land terminals, but we have not been made aware of any. [CONFIDENTIAL ✂].

Potential mitigations

4.29 Even if users of Inmarsat's land terminal users do experience blocking, we have identified a number of ways that they can mitigate disruption, including:

a) using an alternative means of communications, such as satellite services from a different supplier which operate on different frequencies or terrestrial networks;
b) upgrading their terminals to more resilient models; or
c) where the terminals are portable, moving to avoid blocking.

4.30 As explained in our Impact Assessment in Annex A5 (paragraph A5.46), while some of these options may incur a cost to the user, we expect that these incremental costs will be relatively low. We consider any such costs are likely to be a small proportion of the overall cost of the user's operations and objectively justifiable compared to the benefits that would be lost by the restrictions we would otherwise have to place on IMT deployments to avoid those costs.

Impact of protections on mobile use of 1492-1517 MHz

4.31 Imposing restrictions on mobile use of this spectrum to protect land terminals would significantly reduce the benefits of access to this spectrum for IMT. As explained in paragraphs 3.5-3.6, allowing mobile operators unrestricted access to this spectrum should enable stronger connectivity and improved IMT services to consumers, particularly in areas where there is currently limited coverage. In that context, we note that Inmarsat's range of terminals includes devices designed to be used in vehicles which circulate between population centres along major roads, as well as devices designed for communications to and from boats which navigate along rivers and the coast. As such, establishing protection zones around land terminals (and particularly if we established protection zones around areas in which non-stationary terminals are used) would mean effectively sterilising the 1492-1517 MHz block across the significant portions of the UK landmass and potentially limiting IMT use of the upper 1.4 GHz band to indoors only.

[81] Viasat, CFI response, p. 3, Q. 1.

Our provisional view

4.32 Taking into account our policy objectives and relevant legal duties, and for the reasons set out above and in our Impact Assessment in Annex A5,[82] our provisional view is that the benefits of making the spectrum available for IMT outweigh any potential adverse impacts on users of land terminals. As a result, we do not propose to separately protect land terminals, meaning that land terminals would not be protected from the date the award winners(s) use the upper 1.4 GHz block. We welcome evidence on our provisional view and in particular:

a) any evidence that Inmarsat's land terminals are used for the operation of critical national infrastructure or safety purposes;
b) any evidence that it is not technically or practically feasible to replace Inmarsat land terminals, including through alternative solutions or upgrades; and
c) the impact of protecting land terminals on the ability of mobile network operators ("**MNOs**") to use the spectrum and the benefits to consumers and citizens that may be foregone.

Future services

4.33 We note Viasat's arguments regarding the growth of industries using its L-Band services. We are however mindful that the 1.4 GHz band was identified for IMT use at WRC in 2015, harmonised in the EU in 2018 and ECC Report 299 was published in 2019. Our spectrum management strategy for the 2020s also made clear that spectrum users should ensure that their equipment is resilient to blocking. As a result, Viasat and relevant users should have been fully aware of upcoming use of IMT use in the upper 1.4 GHz band for many years as well as the need to upgrade equipment to mitigate the risk of blocking. In this context, designing equipment for future uses which is not resilient to IMT blocking is a known risk, and we consider that any impact must be mitigated before these services are brought to market.

4.34 Taking into account our policy objectives and relevant legal duties, our provisional view is that it would not be appropriate to protect future services which have not been designed with resilience to adjacent band users in mind. Our provisional view is that such further restrictions would significantly impact the ability of mobile operators to use the upper 1.4 GHz band to the detriment of consumers and would not achieve optimal use of the spectrum.

PMSE

Audio links

4.35 While it is possible that PMSE audio links could suffer interference from IMT use of 1492-1517 MHz, our provisional view is that the risk of interference is low. In particular, we

[82] Paragraphs A5.46-A5.48.

understand that they generally have high quality filters and receivers and are likely to use narrow beam directional antennas.[83]

4.36 Our provisional view therefore is that existing licensees who use 1517-1518 MHz for audio links should be able to continue to do so, with a low risk of interference. We also propose to continue to grant new PMSE audio link licences in the 1517-1518 MHz band. While no spectrum licence guarantees protection from interference from other services, applicants for a new PMSE licence should be aware of the potential for blocking from IMT use in the adjacent band. We intend to make that clear as part of the application process and/or on relevant PMSE pages on our website.

4.37 We welcome evidence on our provisional view and in particular any evidence that audio links could suffer interference from IMT use of 1492-1517 MHz.

Telemetry

4.38 Telemetry systems used for motorsports (e.g. by Formula 1) use spectrum between 1.4 and 1.5 GHz. We understand that these users are looking for alternative spectrum for their telemetry systems, and we have assumed for the purposes of this consultation that they will not be using this spectrum by the time we make it available for IMT.

4.39 As a result, we do not expect to continue to make PMSE licences authorising PMSE use of 1492-1517 MHz for telemetry systems available after end 2025.

Consultation questions

Question 6: Do you agree with our proposal not to put in place restrictions on IMT use of this spectrum to protect:

(a) land terminals;

(b) potential future uses of the 1.5 GHz spectrum; or

(c) PMSE users.

In this regard, we particularly welcome:

- any evidence that Inmarsat's land terminals are used for the operation of critical national infrastructure or safety purposes;
- any evidence that it is not technically or practically feasible to replace Inmarsat land terminals, including through alternative solutions or upgrades; and
- any evidence on the impact of protecting land terminals on the ability of mobile network operators ("**MNOs**") to use the spectrum and the benefits to consumers and citizens that may be foregone.

[83] Discussion with [CONFIDENTIAL ✂] on 14 June 2024.

Question 7: Are you able to provide any evidence on the likelihood of audio links suffering interference from IMT use of 1492-1517 MHz?

5. Coordination

Summary

5.1 In this section, we explain the coordination requirements that we propose to impose on users of the upper block of the 1.4 GHz band. Our proposals are based on ECC Report 299, which recommends measures to address potential blocking of satellite mobile earth stations ("**MES**") operating in bands above 1518 MHz.

5.2 We propose to establish zones in which the power flux density ("**PFD**") at which mobile operators are permitted to transmit is limited ("**PFD limited zones**"). These zones will cover operational areas of relevant ports and airports, within which licensees must ensure that the mobile supplementary downlink ("**SDL**") PFD must not exceed the limits set out in Section 6. These limits, derived from Table 13 of ECC Report 299, are defined in two phases. Initially, Phase 1 limits will apply, transitioning to less stringent Phase 2 limits at a later date.

5.3 Additionally, as explained in Section 6, we propose to require licensees to comply with out-of-band emissions limits above 1518 MHz.

5.4 We intend to define PFD limited zones using complex polygons in order to minimise the areas where mobile deployments will be restricted. Example PFD limited zones are provided at Annex A11 of this consultation.

5.5 We would require licensees to perform coordination calculations for each base station deployment that may generate blocking within a PFD limited zone, to ensure the planned deployment would not exceed the PFD limit within the zone.

5.6 To facilitate the coordination procedure, we have considered options for defining **coordination zones** around each of the PFD limited zones which may be used to guide where mobile deployments are required to be coordinated. We expect deployments to be possible without modification in many parts of the coordination zones.

5.7 For protected airports, we propose that coordination would be required within an area defined by a polygon enclosing a fixed range around the PFD limited zone for the relevant airport. We propose to require coordination within a radius of 20 km around each protected airport for Phase 1 (or 10 km for deployments with lower height and power), reducing to 5 km for Phase 2 PFD limits when these come into effect.

5.8 For protected ports, we propose not to define specific coordination zones while Phase 1 protections are in place, and instead require licensees to judge where coordination is required to ensure that there is no circumstance in which the PFD limits are exceeded. Once we transition to Phase 2, we propose to require coordination within an area defined either by a complex polygon, or a set of grid squares, drawn around each protected area.

5.9 We would require licensees to carry out the coordination calculations, using a coordination method and parameters specified by Ofcom.

5.10 Table 5.1 below summarises our coordination proposals.

Table 5.1: Summary of coordination proposals at Phase 1 and Phase 2

	PFD limits (dBW/m²)		Definition of PFD limited zones	Size of areas in which coordination would be required	Definition of coordination zones
	1492-1512 MHz	1512-1517 MHz			
Phase 1					
Airports	-53.5	-63.4	Complex polygons	Large cells: 20 km Small cells: 10 km	Polygons around PFD limited zones
Ports	-74.9	-85.9	Complex polygons	Large cells: 30 km or more Small cells: 25 km	Ofcom would not specify coordination zones; licensees would decide which deployments require coordination.
Phase 2					
Airports	-30.9	-40.9	Complex polygons	Large cells: 2 km Small cells: 1 km	Polygons around PFD limited zones
Ports	-30.9	-40.9	Complex polygons	Large cells: 2 km Small cells: 1 km	Polygons around PFD limited zones

Background

5.11 The 1492-1517 MHz band has been harmonised for mobile supplemental downlink ("**SDL**") under CEPT's ECC Decision 17(06).

5.12 Measurements of satellite terminals reported in ECC Report 299 show that some satellite services in 1518-1559 MHz may be susceptible to harmful interference from mobile base stations in the 1492-1517 MHz band. Older satellite receivers will typically be less resilient to interference from the adjacent band. It is expected that these older, less resilient receivers will be phased out in the future. As set out in Section 3, we think it is important to encourage users to upgrade their receivers as quickly as possible.

Call for Inputs proposals

5.13 In the October 2023 CFI, we explained the coexistence analysis we had carried out to estimate the areas in which satellite receivers could be vulnerable to interference from adjacent band mobile use. We set out our initial views on establishing coordination zones around ports and airports where new mobile base station deployments would be required to demonstrate that they will not breach the PFD limits within the defined PFD limited zones.

5.14 We sought stakeholders' views on two options for defining the PFD limited zones:

a) a simple polygon or single point for each port or airport at which the PFD is measured; or
b) complex polygons defined by the extent of satellite receiver activity in the protected area.

5.15 We also set out two similar options (simple or complex polygons) for defining the wider coordination zones around the PFD limited zones.

5.16 We noted that PFD limited zones defined by simpler shapes may make deployments more straightforward, but that complex shapes could lead to more efficient use of the spectrum. We also noted that coordination zones defined as complex polygons could make deployments more complex.

Stakeholders' responses

5.17 Stakeholders' responses to our coexistence analysis are discussed in more detail in Section 6. Below, we summarise the feedback relevant to our proposed implementation of PFD limited zones and the associated coordination requirements:

a) The mobile network operators ("**MNOs**") agreed that protection measures are required, but encouraged us to be proportionate in their use, to apply them to only those areas where interference will have a significant impact and to minimise the restrictions on availability for mobile use. In general, they supported the use of complex polygons to define PFD limited zones for efficiency and to minimise restrictions on mobile use. They told us that simple shapes (e.g. circles) could be used for coordination areas.[84]
b) The Global System for Mobile Communications Association ("**GSMA**") suggested we make available concentric circles to show the different probability of interference within coordination zones.[85]
c) The Maritime and Coastguard Agency ("**MCA**") and **John Shaw** all stated that there is no need to overcomplicate the zones and so simple shapes would be suitable for PFD limited and coordination zones.[86]
d) **Viasat** expressed no preference for complex or simple polygons, so long as services in the adjacent band received adequate protection.[87]

Our revised proposals

5.18 In light of responses to the CFI, we have considered the options for PFD limited zones and coordination zones in greater detail, and present below revised proposals on:

a) the appropriate PFD limits to use;
b) how we should define the PFD limited zones;
c) where coordination is likely to be necessary;

[84] BT/EE, CFI response, p. 4, Q. 1, and p. 5, Q. 3 and 7; H3G, CFI response, p. 9; VMO2, CFI response, p. 2, Q. 2.; Vodafone, CFI response, p. 2, Q. 1, and p.3, Q2-3.
[85] GSMA, CFI response, p. 3, Q. 3.
[86] MCA, CFI response, p. 3, Q. 3, Shaw J, CFI response, p. 5, Q. 3.
[87] Viasat, CFI response, p. 10, Q. 3.

d) how to define the coordination zones;
e) who should carry out the coordination; and
f) how coordination calculations should be carried out.

PFD Limits

5.19 We maintain our provisional view that areas identified in Section 3 as requiring protection due to potential receiver blocking should be protected by PFD limited zones. Within these zones, we propose that the mobile PFD will be restricted to the limits specified in Table 13 of ECC Report 299 ("**the limits**"), which are set out in Table 5.2 below. These limits were compiled based on an extensive series of measurements performed on a range of different satellite receivers and have been recognised internationally. The limits account for mobile network base stations transmitting on multiple channels or multiple mobile network operators using the band, and therefore represent the most stringent set of limits of those given in that report.

Table 5.2: Proposed PFD limits, as specified in Table 13 of ECC Report 299

	Phase 1 PFD limits (dBW/m^2)		Phase 2 PFD limits (dBW/m^2)	
	1492-1512 MHz	1512-1517 MHz	1492-1512 MHz	1512-1517 MHz
Ports	-74.9	-85.9	-30.9	-40.9
Airports	-53.5	-63.4	-30.9	-40.9

5.20 We also note that for the CFI we considered interference due to only a single 5 MHz IMT channel. Having considered responses to the CFI, and following our further analysis, we have now modified our proposed coordination ranges based on PFD limits to accommodate multiple IMT channels being used within the band. In the event that the 1492-1517 MHz band is split between multiple licensees, each licensee will be required to adhere to PFD limits in proportion to their spectrum holding in the band. This means that the coordination areas we are now proposing are larger than those indicated in the CFI. The limits set out in Section 6 (Table 6.1) and in Annex A10 have therefore been expressed as PFD per 5 MHz bandwidth.

5.21 We considered the alternative Option A and Option B PFD limits described in ITU-R Recommendation M.2159 Annex 3. Option A PFD limits match those in ECC Report 299 Table 13, for 3 dBi MSS antennas. Additional lower limits are given for protection of MSS with high gain directional antennas, for the worst-case scenario in which an IMT deployment falls within the main beam of a directional MSS antenna, for example if it is steered to a low elevation angle. Our view is that this is very unlikely to occur and that these lower limits are therefore unnecessarily restrictive.

Definition of PFD limited zones

Summary of responses to the CFI

5.22 Viasat did not have a preference for how PFD limited and coordination zones are defined, so long as adequate protection is provided for services in the adjacent band.[88]

5.23 John Shaw and the MCA commented that the terrain around ports is likely to be 'flattish' or gently sloping towards the sea, and so there is no need to over complicate the definition of PFD limited zones and coordination zones.[89]

5.24 BT/EE stated that there may be efficiency benefits in using complex polygons compared with simple shapes, even if this makes the spectrum more difficult to deploy.[90]

5.25 The GSMA favoured complex polygons, to show the more complex interference picture, but also suggested that concentric circles could be provided to show the probability of interference within the coordination zones.[91]

5.26 H3G did not specifically express a view on the makeup of the PFD or coordination zones, but nevertheless suggested that we carry out more detailed analysis for each protected port and airport.[92]

5.27 Vodafone thought that complex polygons would be preferable for the PFD limited zones.[93]

Our proposal

5.28 Having considered responses to the CFI, we propose to define PFD limited zones as **complex polygons**, drawn around the areas which we have identified as requiring protection. Examples of these are shown in Annex A11. We consider this would limit the size of PFD limited zones, and keep the protected areas to a minimum, helping to ensure efficient use of spectrum.

5.29 We have also considered whether defining these complex polygons as a set of points, rather than an entire boundary, could make carrying out coordination calculations easier for licensees. We are interested in stakeholders' views on this.

Coordination zones

5.30 We propose to define **coordination zones** surrounding and associated with each PFD limited zone. Licensees would be required to carry out coordination calculations before deploying any new base stations (or modifying any previously deployed base station) within a coordination zone. Coordination calculations would be used to demonstrate that base station deployments will not cause the mobile PFD to exceed the limits within the PFD limited zones.

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[88] Viasat, CFI response, p. 10, Q. 3.
[89] Shaw J, CFI response, p. 5, Q. 3; MCA, CFI response, p. 7, Q. 3.
[90] BT/EE, CFI response, p. 5, Q. 3.
[91] GSMA, CFI response, p. 4, Q. 3.
[92] H3G, CFI response, p. 9, Q. 3.
[93] Vodafone, CFI response, p. 3, Q. 3.

5.31 Our revised coexistence model and calculations of where coordination is likely to be necessary are set out in this sub-section.

Parameters for modelling required coordination zones

5.32 In response to the CFI, Vodafone said that the parameters we proposed for computing these zones were pessimistic and therefore not typical of other UK deployments in this band. In light of Vodafone's comments,[94] we have modelled how deployments using different parameters would impact the size of the coordination zones.

5.33 In contrast, Viasat considered that size of the coordination zones should be based "on the lowest PFD limits, conservative assumptions about terrain loss… and should assume the base station transmits with the maximum permissible power".[95]

5.34 We have modelled how the typical UK mobile base station parameters set out in Table 5.3 would affect the zones where base stations could cause interference to satellite receivers within nearby ports and airports.[96] We used two sets of parameters, representing 'large cells' using worst case conditions, and 'small cells' with reduced power, height and increased downtilt to simulate deployment types which may be more common in practice.

Table 5.3: IMT parameters used for coordination purposes.

	Mobile base station characteristics (large cells)	Mobile base station characteristics (small cells)
Transmit EIRP: 1492-1512 MHz	68 dBm/5 MHz	58 dBm/5 MHz
Transmit EIRP: 1512-1517 MHz	58 dBm/5 MHz	48 dBm/5 MHz
Bandwidth	5 MHz	5 MHz
Antenna gain (max)	18 dBi	18 dBi
Antenna tilt	-3°	-6°
Station height	30m	15m
Polarisation	Horizontal	Horizontal
Propagation Model	ITU-R P.452-18 (20%)	ITU-R P.452-18 (20%)

[94] Vodafone, CFI response, pp. 2-3, Q. 1.
[95] Viasat, CFI response, p. 9, Q. 2.
[96] The model is based on our assumption of typical UK mobile base station parameters.

Coordination around airports

Size of coordination zones

5.35 Our modelling showed that deployments of ‘large cell’ base stations around airports could generate a PFD above the limits within airports at ranges of up to 20 km for Phase 1 PFD limits, or approximately 2 km for Phase 2 PFD limits.

5.36 For base station deployments with ‘small cell’ parameters, these distances are reduced to 10 km for Phase 1 PFD limits or approximately 1 km for Phase 2 PFD limits.

5.37 As an example, Figure 5.1 and Figure 5.2 show the areas where mobile deployments could cause the PFD limits to be exceeded at London Heathrow Airport (Terminal 1) in Phase 1 and Phase 2, respectively, for ‘large cells’ and ‘small cells’ parameters.

5.38 The PFD limited zone is shown in red at the centre of the diagrams, with the grey and blue shaded areas showing where IMT deployments may give a PFD above the Phase 1 limits for ‘large cell’ and ‘small cell’ deployments respectively. This shows where mobile deployments would be likely to need modification in order to stay within the PFD limits, and therefore indicates the required extent of coordination around the airport.

5.39 We have performed this analysis for all of the international airports in the UK, with similar results. We have found that because Heathrow Airport is the largest of these airports it represents the biggest footprint for coordination, so we have used it here for illustrative purposes. All other airports have similar or slightly smaller ranges for the potential to exceed PFD limits.

Figure 5.1: Ranges where IMT deployments may cause PFD limits to be exceeded within the London Heathrow Airport PFD limited zone (inner red area) for worst case 'large cells' (grey area) and alternative 'small cells' (blue area) IMT deployments in Phase 1. A 20km radius from the centre of the PFD limited zone is shown (green outline).

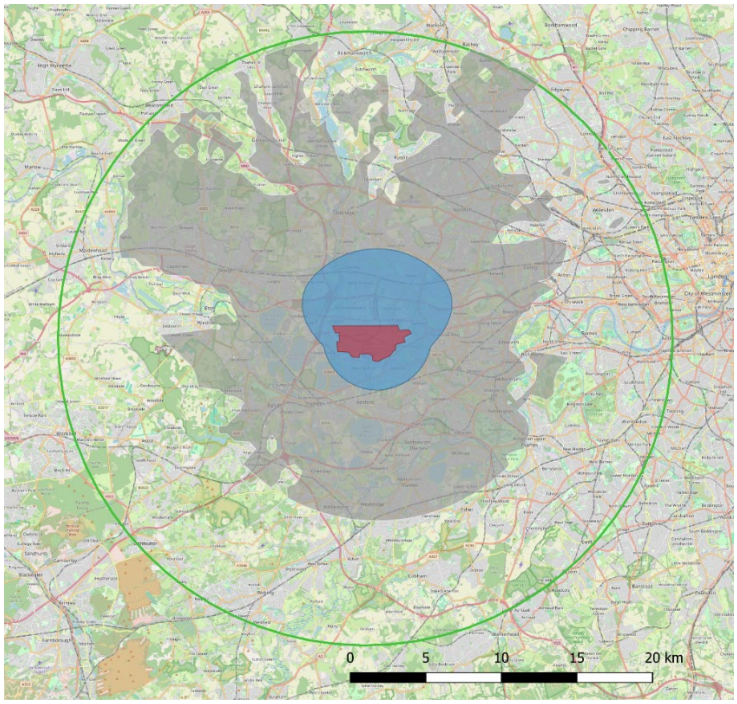
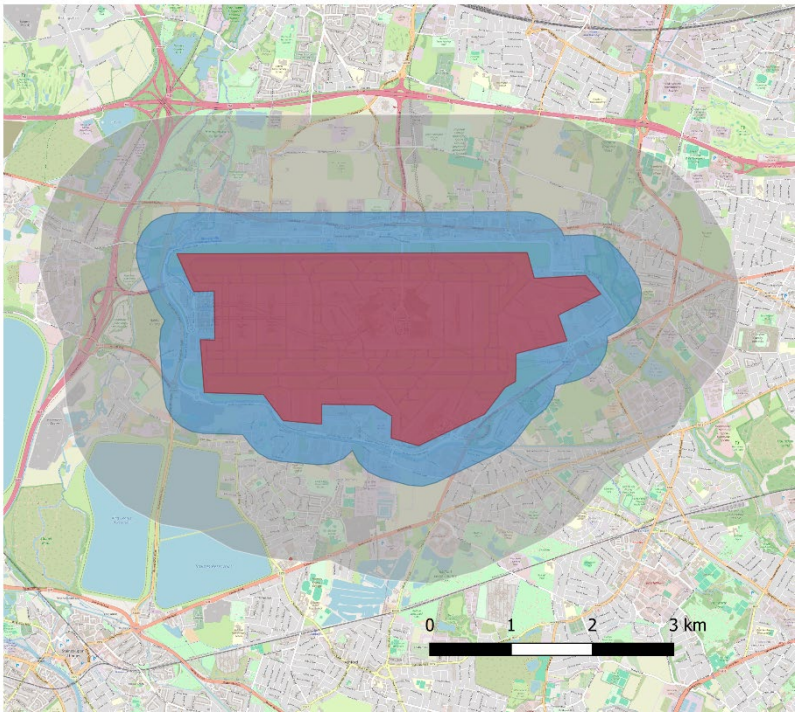


Figure 5.2: Ranges where IMT deployments may cause PFD limits to be exceeded within the London Heathrow Airport PFD limited zone (inner red area) for worst case 'large cells' (grey area) and alternative 'small cells' (blue area) IMT deployments in Phase 2.



Usability of spectrum within the coordination ranges

5.40 As shown in Figure 5.1 above, the ranges at which mobile base station deployments may cause PFD limits to be exceeded are up to 20km at Phase 1. However, there are significant areas within this range where base stations can be deployed without generating a PFD above the limits in the PFD limited zones (e.g. for large cells, the area within the green coordination circle that is not shaded). We therefore expect more than half of deployments within the proposed coordination zones to pass coordination without modification at Phase 1. With some modification to reduce the mobile EIRP transmitted towards the PFD limited zone, we expect that deployment will be possible in most of the coordination zone.

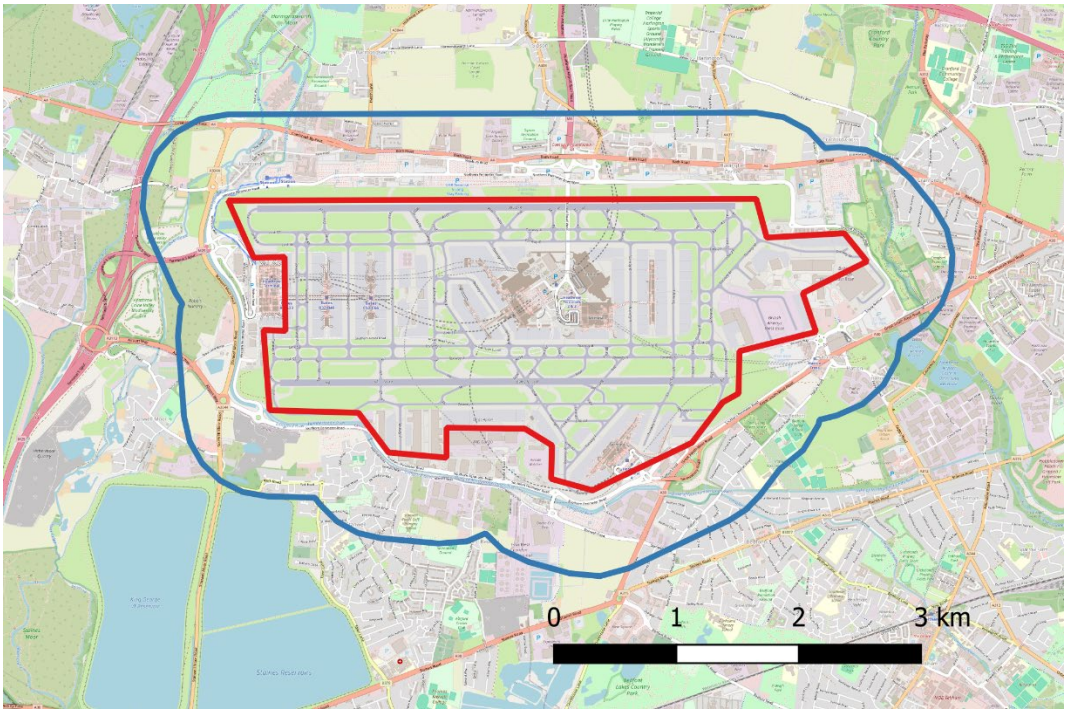
5.41 As shown in Figure 5.2, at Phase 2 the coordination zones will be much smaller and so coordination calculations will be required in fewer locations. We would expect modification to be required in proportionately more of these smaller coordination zones in order to stay within the PFD limits as propagation conditions will be less variable over the shorter distances.

5.42 Figure 5.3 shows the proposed PFD limited zone for London Heathrow airport and the area around this within which we expect coordination to be difficult to achieve for Phase 1 PFD limits. For this analysis, we have assumed that the EIRP from the mobile base station towards the PFD limited zone can be reduced by up to 30dB compared with the maximum 'large cell' parameters described above, by using directional antennas pointing away from the PFD limited zone, antenna downtilt, reduced antenna heights and/or reduced transmit power.

5.43 For Phase 1 PFD limits, our analysis shows that deployments within approximately 700m of the PFD limited zone are unlikely to pass coordination. This area is indicated by the outer blue outline around the outside of the airport and its PFD limited zone.

5.44 For Phase 2 PFD limits, this distance reduces to approximately 100m.

Figure 5.3: London Heathrow Airport PFD limited zone (inner red outline) and the areas within which we expect coordination to be difficult to achieve at Phase 1 PFD limits (outer blue outline).



Coordination around ports

5.45 Figure 5.4 shows some results from our modelling of mobile deployments around Southampton. Deployments of 'large cell' base stations around ports are likely to breach the Phase 1 PFD limits within ports at ranges of up to approximately 30 km. In some limited circumstances, large cell deployments on high ground could cause Phase 1 PFD limits to be breached at greater distances from the port.

5.46 For 'small cell' deployments, deployments are likely to breach the Phase 1 PFD limits at ranges of up to approximately 25 km from the port. Even if 'small cell' deployments are placed on higher ground, the range at which they may breach the PFD limits remains up to approximately 25 km from the port.

5.47 For Phase 2 PFD limits, 'large cell' base station deployments could breach the PFD limits at ranges of 2 km from the edge of the PFD limited zone. For 'small cell' deployments, this range is reduced to approximately 1 km or less.

5.48 We note that the PFD limits for ports are significantly lower than those for airports at Phase 1, whilst both ports and airports will have the same limits at Phase 2. We would therefore expect coordination zones around ports to be bigger than those around airports at Phase 1, but approximately the same sizes at Phase 2.

5.49 As explained in Section 3, our preferred option is that the 51 major ports listed in Annex A7 would require protection although we are consulting on whether it may be appropriate to protect all 160 major and minor ports listed in Annex A7.

Phase 1

5.50 We note that if we were to define coordination zones of 25-30 km around the 51 major ports we propose to protect, this would mean that many of the coordination zones would overlap with each other, with the result that mobile licensees would have to carry out coordination calculations against several different PFD limited zones in some cases. There would be more coordination calculations to carry out (which may result in more complexity) if we decide to protect more than 51 ports. However, whilst the maximum distance at which Phase 1 PFD limits could be breached within the port is large, we expect that most places within this range will either meet coordination without modification, or will meet coordination with modest adjustments to transmit power, height, antenna direction or downtilt.

5.51 To reduce the need for multiple coordination calculations to be performed in certain areas, we aim to combine nearby port areas into single PFD limited zones. For example, Figure 5.4 below shows a proposed PFD limited zone to protect Southampton and Portsmouth and their approaches in the Solent and Southampton Water.

5.52 The areas within which a 'large cell' and 'small cell' base station deployment could generate a PFD above the Phase 1 PFD limits in the north end of the PFD limited zone are shown. This extends to up to 25 km from the port for 'small cell' deployments, and in isolated locations well beyond 30 km for 'large cell' deployments. A 30 km wide zone is shown around the PFD limited zone. A significant part of this zone will allow a new base station to be deployed without modification, however, there are also isolated areas well outside the 30 km range where a base station may still cause the PFD limits to be exceeded.

5.53 Figure 5.5 shows the areas within which we expect coordination to be difficult to achieve at Phase 1. This has been computed assuming the EIRP of a new base station towards the PFD limited zone can be reduced by up to 30dB compared with the 'large cell' parameters given above. It could extend to a range of up to 8 km from the edge of the PFD limited zone depending on terrain and clutter in the area.

Figure 5.4: Proposed PFD limited zone for Southampton, Portsmouth and the Solent (red area), with our analysis of where a large cell (black contours) or small cell (blue contours) base station could generate a PFD above the phase 1 PFD limits within Southampton. An area extending 30 km around the PFD limited zone is shown in green.

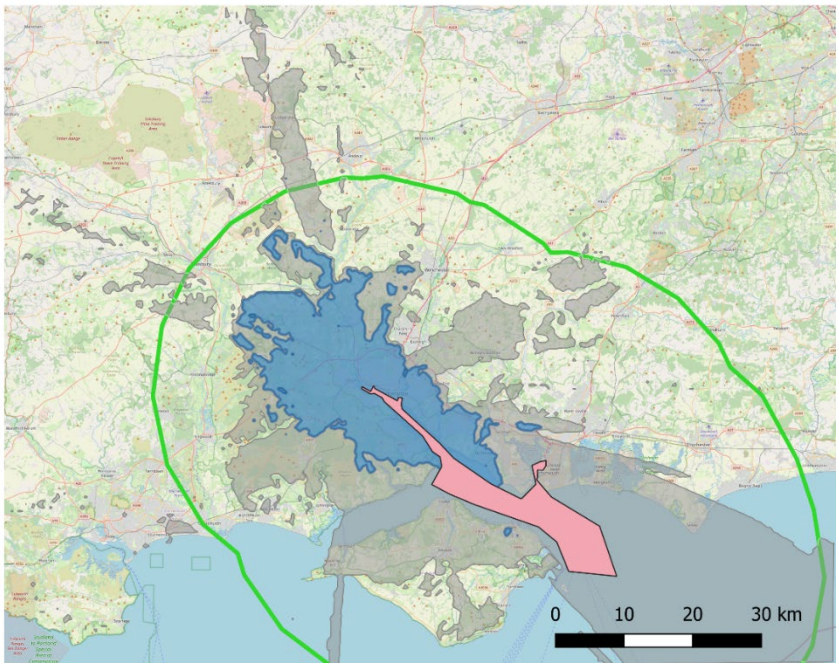
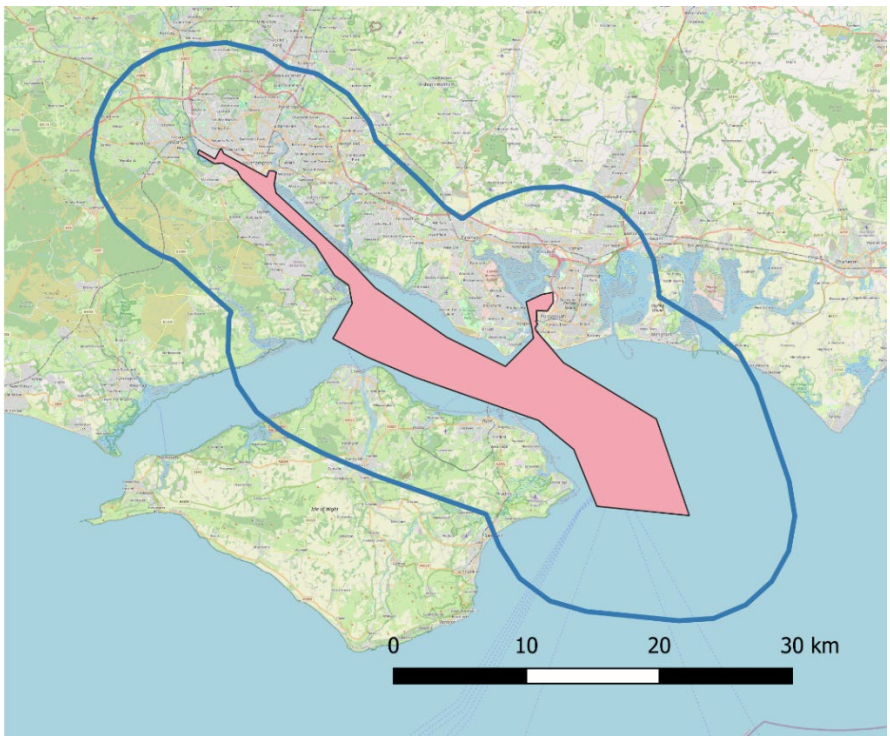


Figure 5.5: Areas around the Southampton, Portsmouth and the Solent PFD limited zone where it may be difficult to achieve coordination at Phase 1. The PFD limited zone is shown in red, areas where coordination will be difficult to achieve are enclosed in blue.

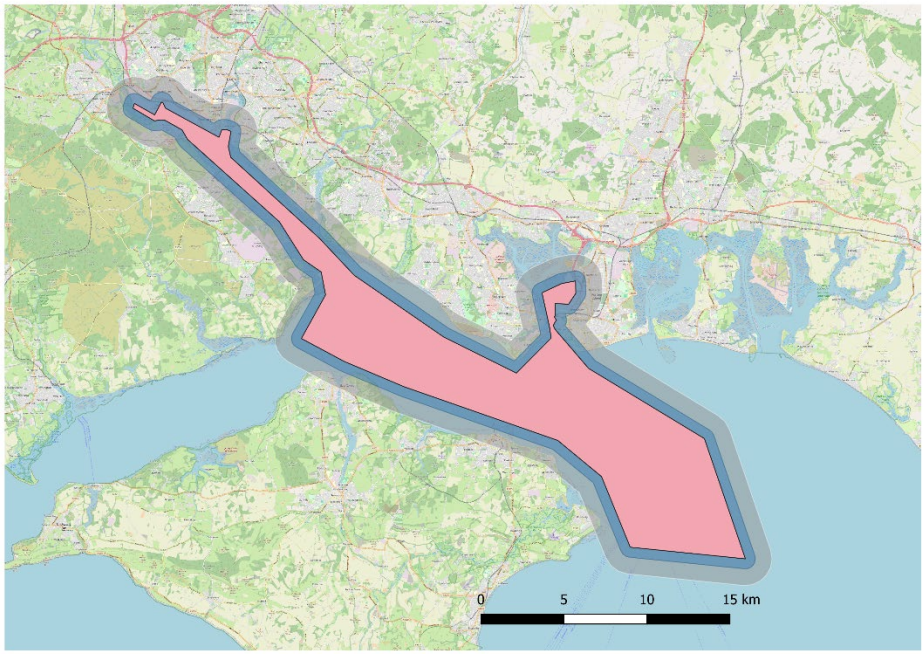


Phase 2

5.54 At Phase 2, the size of the coordination zones required to ensure mobile deployments do not breach the Phase 2 PFD limits within the port are much smaller (around 2 km from the edge of the PFD limited zone for 'large cell' base station deployments and 1 km for 'small cell' base station deployments). We expect that it will be possible for operators to achieve coordination in these zones in most cases with modifications to base station deployments.

5.55 For example, Figure 5.6 below shows the areas where base station deployments could cause Phase 2 PFD limits to be exceeded around Southampton, Portsmouth and the Solent. Coordination will be required within these areas. We expect some modification will be required to most deployments within this coordination zone in order to maintain the PFD within the Phase 2 limits. We expect coordination to be achievable for deployments at distances of more than approximately 100m from the edge of the PFD limited zone.

Figure 5.6: Areas around the Southampton, Portsmouth and the Solent PFD limited zone (in red) where 'large cell' (in grey) and 'small cell' (in blue) deployments may cause the Phase 2 PFD limits to be exceeded.



Definition of coordination zones

5.56 Responses to the CFI generally supported use of simple shapes for coordination zones.[97]

[97] BT/EE, CFI response, p. 4, Q. 1, and p. 5, Q. 3 and 7; H3G, CFI response, p. 9; VMO2, CFI response, p. 2, Q. 2.; Vodafone, CFI response, p. 2, Q. 1, and p.3, Q2-3; GSMA, CFI response, p. 3, Q. 3; MCA, CFI response, p. 3, Q. 3, Shaw J, CFI response, p. 5, Q. 3.

5.57 Having further considered the coordination that would be required around ports and airports, we are now seeking stakeholders' views on the following options for defining coordination zones around ports and airports:

a) Option 1: No specific coordination zones
b) Option 2: Circles defined by a radius around a central point
c) Option 3: A polygon around the PFD limited zone
d) Option 4: A series of grid squares

Option 1: No specific coordination zones

5.58 This would mean we would not define any specific coordination zones around ports or airports, and instead we would require licensees to apply their own judgement to decide where coordination is required in order to stay within the PFD limits in the PFD limited zones. In the paragraphs above we have provided recommendations about the approximate distances from ports and airports at which coordination may be required, for the large cell and small cell models also described above.

5.59 We are currently not minded towards this option for airports, as we think defining coordination zones around airports is likely to be simpler than for it is for ports and could be clearer and more certain for licensees. However, our initial view is that at ports this option may be simpler for licensees than complying with multiple different coordination zones, particularly while Phase 1 PFD limits are in place, given the number of coordination zones that would be required, and the fact that they overlap. However, we note that potential licensees may find it preferable to have defined coordination zones, and we are interested in stakeholders' views.

Option 2: Coordination zones defined as circles around a single point in each port or airport

Airports

5.60 At airports, our provisional view is that these circles would have radii of:

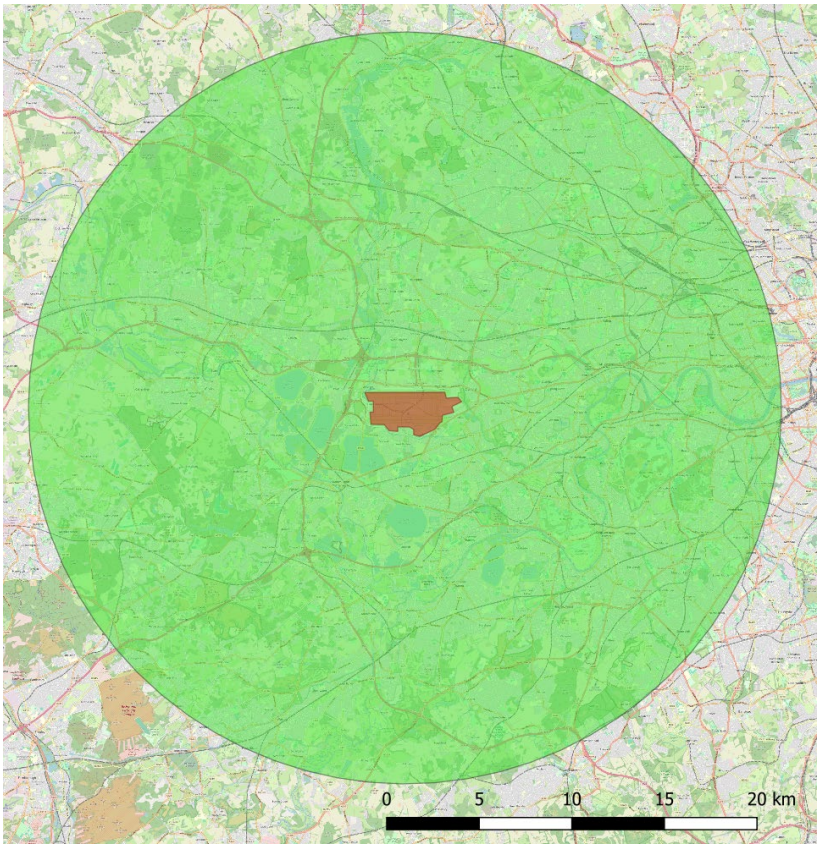
a) 20 km for deployments at Phase 1, and
b) 5 km for deployments at Phase 2.

5.61 For deployments with EIRP and antenna height less than or equal to the 'small cell' values given in Table 5.3 AND downtilt greater than or equal to the value given in Table 5.3, our provisional view is that these circles would have radii of:

a) 10 km for deployments at Phase 1, and
b) 5 km for deployments at Phase 2.

5.62 Figure 5.7 shows an example coordination radius of 20 km around London Heathrow Airport.

Figure 5.7: Illustration of a circular coordination zone around a central point at London Heathrow Airport, for Phase 1 PFD limits and 'large cell' IMT deployments.

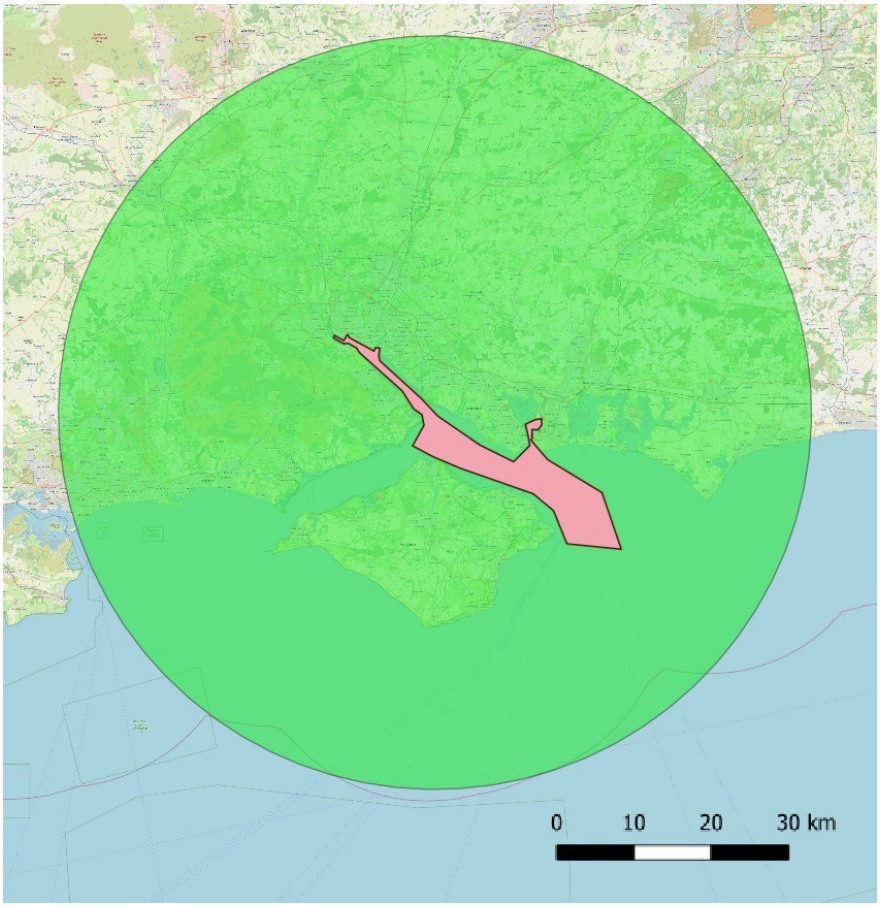


Ports

5.63 At ports, coordination would be required for deployments within a defined radius from a central point in the port's PFD limited zone. Given that the PFD limited zones for ports may vary significantly in size, we propose that the size of the coordination zones would be different for each protected port. We would require licensees to perform coordination calculations between the proposed IMT deployment and the nearest point in the PFD limited zone. This may require licensees to coordinate deployments against more than one PFD limited zone.

5.64 At Phase 1, these circles could be much more than 30 km in radius and coordination zones around ports would overlap with each other. Figure 5.8 Illustrates a circular coordination zone around Southampton for Phase 1 PFD limits.

Figure 5.8: Illustration of a circular coordination zone around a central point in the Southampton and the Solent PFD limited zone, for Phase 1 PFD limits and 'large cell' IMT deployments.

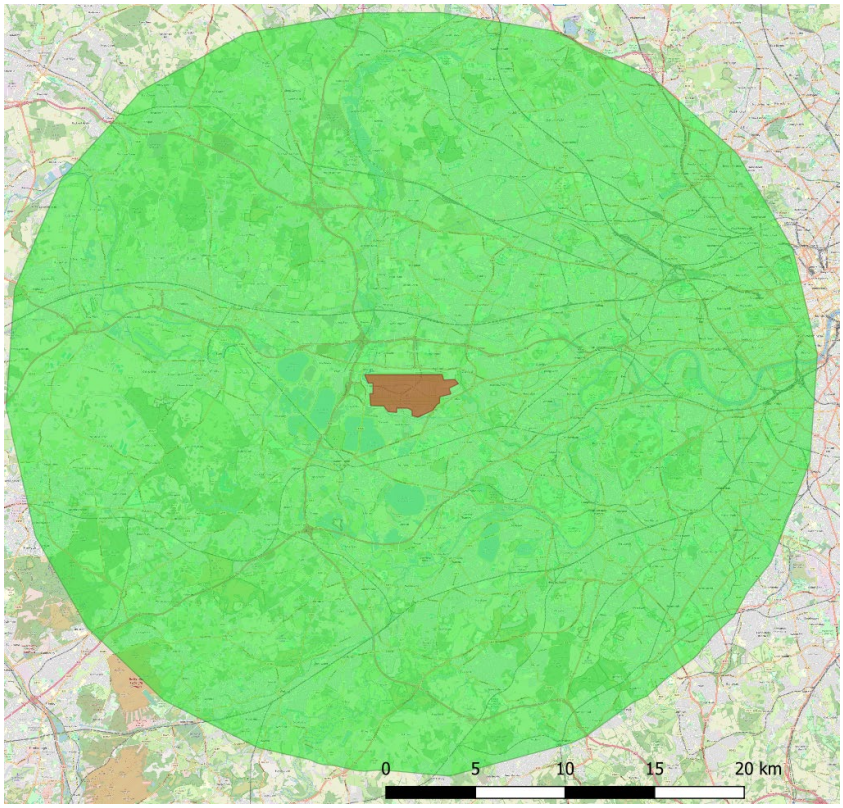


Option 3: Coordination zones defined as polygons around PFD limited zones

Airports

5.65 We would create polygons defining the zones around each airport within which coordination will be required. These would be similar in size to the circles described in Option 2, but the overall zones requiring coordination may be slightly larger. At Phase 1, our provisional view is that the coordination zone would extend 20 km from the boundary of the PFD limited zone, whilst at Phase 2 these would be reduced to a 2 km zone. Figure 5.9 shows a polygon defining a 20 km coordination range around the London Heathrow airport PFD limited zone.

Figure 5.9: Illustration of a coordination zone defined as a polygon around the London Heathrow Airport PFD limited zone, for Phase 1 PFD limits and 'large cell' IMT deployments.

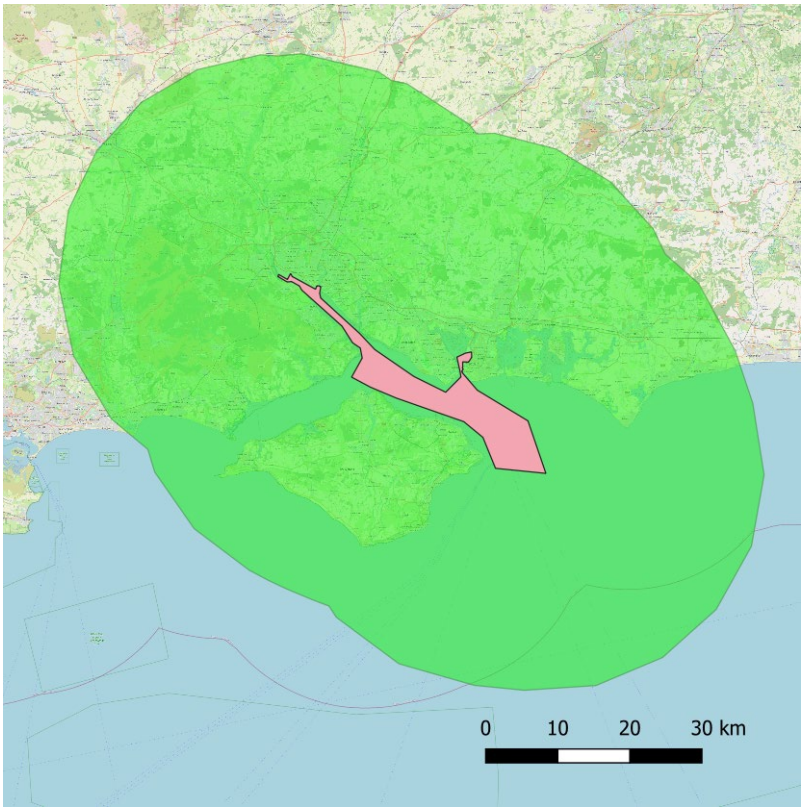


Ports

5.66 Our provisional view is that coordination zones would be defined by a polygon enclosing an area approximately 30 km larger than the corresponding PFD limited zone at Phase 1. The coordination zone would be reduced to 2 km around the PFD limited zone at Phase 2. Coordination calculations would be required between deployment locations in the coordination zone and the nearest point on the perimeter of the PFD limited zone. Figure 5.10 shows a coordination zone extending 30 km around the Southampton, Portsmouth and the Solent PFD limited zone.

5.67 This may require licensees to coordinate deployments to more than one PFD limited zone. As for Option 2, we propose to combine coordination zones to simplify them as much as possible, however, at Phase 1, there would still be areas where coordination to multiple ports' (and likely airports') PFD zones would be required.

Figure 5.10: Illustration of a coordination zone defined as a polygon around the Southampton and the Solent PFD limited zone, for Phase 1 PFD limits and 'large cell' IMT deployments.

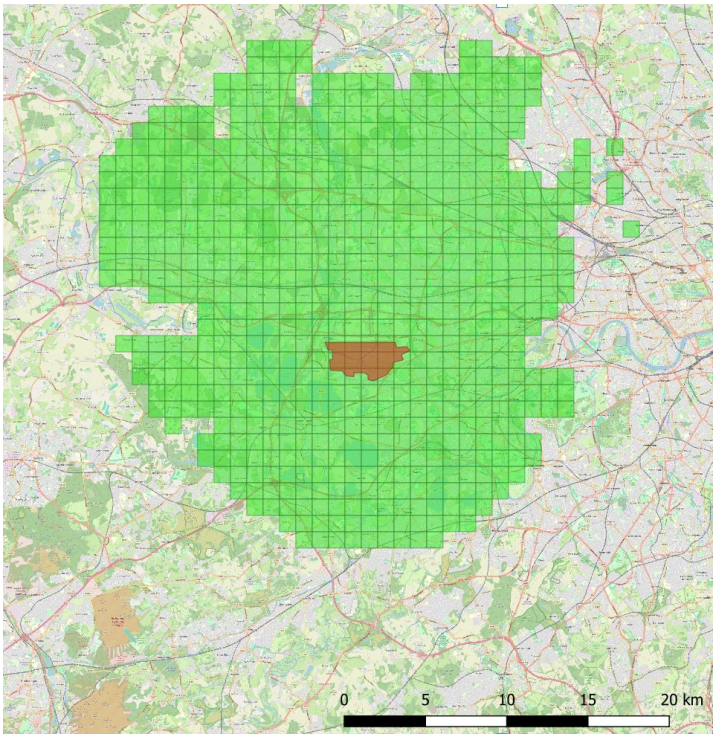


Option 4: Coordination zones defined by a series of grid squares

Airports

5.68 Our provisional view is that coordination zones would be defined by grid squares covering the PFD limited zone and a coordination zone of approximately 20 km around this at Phase 1, reducing to 2 km at Phase 2. We consider that we could use 1 km grid squares to provide sufficient geographical resolution to define the coordination zones, however these could be made larger or smaller, with larger squares being simpler, but smaller squares being more accurate. We would require licensees to perform coordination calculations for each deployment within the grid squares to the nearest point of the relevant PFD limited zone. Figure 5.11 shows how a coordination zone for Phase 1 PFD limits would be defined using 1 km grid squares.

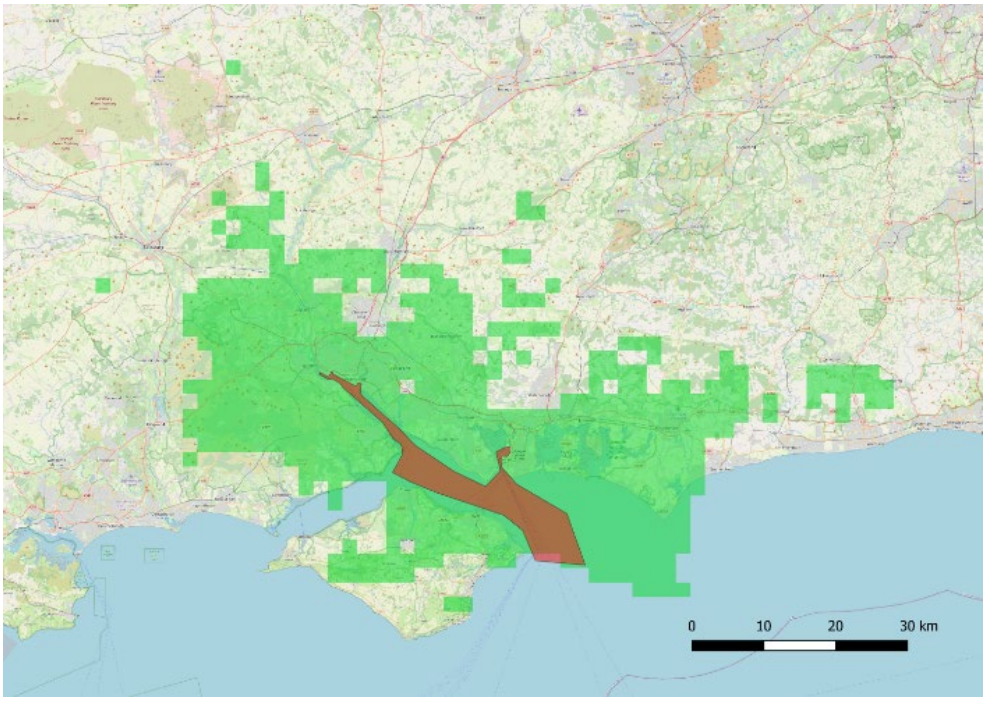
Figure 5.11: Illustration of coordination zones defined as a series of 1 km grid squares around the London Heathrow PFD limited zones, for Phase 1 PFD limits and 'large cell' IMT deployments.



Ports

5.69 Our provisional view is that we do not consider this is a viable approach to coordination zones around ports (particularly at Phase 1), because the list of grid squares in which coordination would be required would be so long as to be unworkable for licensees. As such, we do not propose to consider it further. At Phase 2, we think this would be a similar approach to Option 3 above (coordination zones defined by polygons around PFD limited zones). Figure 5.12 shows how a coordination zone would be defined for Phase 1 PFD limits around Southampton, Portsmouth and the Solent using 1 km grid squares.

Figure 5.12: Illustration of coordination zones defined as a series of 1 km grid squares around the Southampton and the Solent PFD limited zones, for Phase 1 PFD limits and 'large cell' IMT deployments.



Our provisional view

5.70 We provisionally consider that the different approaches to coordination we have outlined above should all ensure the same level of protection for satellite receivers. This is because they would all be defined conservatively to ensure that all areas in which deployment of a mobile base station *could* have an impact on satellite receivers are covered by coordination zones. For the same reason, we do not consider that the different options for defining coordination zones would have an impact on efficient use of spectrum. Provided licensees undertake coordination, they should be able to deploy in all areas in which they will not cause PFD limits to be exceeded.

5.71 Therefore, we consider the main difference between the options set out above relates to how practical they are for potential licensees. In particular, simpler coordination zones (e.g. circles) may be easier to implement in licensees' systems, and may be easier to understand, but they may require coordination in more areas than is necessary. On the other hand, more complex zones (e.g. grid squares), are likely to minimise the size of the areas in which coordination is required, at the expense of potential added complexity for licensees.

Airports

5.72 We are currently minded to define coordination zones around airports as polygons that enclose a fixed range around each of the PFD limited zones (Option 3), on the basis that we think this will be the simplest approach for licensees to implement in practice.

Ports

5.73 We are currently minded not to define specific coordination zones at Phase 1, given the likely size required for coordination zones, we would require licensees to coordinate at all locations that could cause PFD limits to be breached within the defined PFD limited zones

around ports (Option 1). At Phase 2, we are minded to define coordination zones as polygons around the PFD limited zones (Option 3), as we think this would strike an appropriate balance between simplicity for licensees and ensuring the coordination zones are as small as they can be. We consider polygons are most appropriate around ports given the irregular shape of most ports. If we were to draw circles around ports, the circles would likely mean requiring coordination in more areas than necessary.

Who should carry out the coordination?

5.74 In the CFI, we asked respondents for their initial views on whether coordination should be conducted by Ofcom or the licensee.

High level summary of CFI responses

5.75 We received mixed responses to this question in the CFI. MNOs and the GSMA favoured licensees carrying out the coordination:

a) BT/EE suggested "Ofcom provides the detailed database of which, say 100mx100m, pixel locations must be protected to the specified interference signal levels. The licensee could then do the coordination, aggregating interference from multiple base stations as necessary." BT/EE also noted any coordination algorithms would need to be the subject of further consultation.[98]
b) The GSMA said that we should allow licensees to undertake their own planning, using an agreed terrain database.[99]
c) VMO2 said that "Once the principles of coordination are defined by Ofcom, our view is that it should be left to the licensee to implement the necessary coordination".[100]
d) Vodafone noted that this question depends on "whether the 25 MHz in question is awarded to a sole or multiple licensees." It said that if multiple licensees win this spectrum, then "an individual licensee isn't able to carry out the calculation unilaterally and cooperation between the licensees is required, either via Ofcom or a neutral third party such as DMSL."[101]

5.76 However, the MCA and John Shaw both thought Ofcom should carry out the coordination given the potential adverse impact of getting it wrong.[102]

5.77 Viasat thought that it should have a role in the coordination. It said that Ofcom should "require terrestrial operators to provide to Viasat (and Ofcom) the models, assumptions, and calculations to show that proposed operations would meet the established PFD limits and allow Viasat validate these conclusions." It noted this would enable Viasat to provide feedback to MNOs, remove the need for Ofcom as an intermediary, and be consistent with how other national administrations handle inter-service coordination involving satellite spectrum.[103]

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[98] BT/EE, CFI response, p. 5, Q. 6.
[99] GSMA, CFI response, p. 5, Q. 6.
[100] VMO2, CFI response, p. 3, Q. 6.
[101] Vodafone, CFI response, p. 4, Q. 6.
[102] MCA, CFI response, p. 8, Q. 6; Shaw J, P. 9, Q. 6.
[103] Viasat, CFI response, p. 11, Q. 6.

Our proposals

Options we have considered

5.78 In light of responses to the CFI, we have considered whether coordination should be carried out by Ofcom, the licensees, or Viasat.

5.79 We propose that licensees should carry out the coordination. We explain below how we consider each option would work, and why we consider that licensees carrying out the coordination would be the most appropriate option.

Ofcom carries out the coordination

5.80 This would mean that for any deployments which fall within coordination zones, licensees would be required to submit a coordination request to Ofcom. Ofcom would then check whether the proposed deployment would likely result in a breach to the PFD limits within the PFD limited zones and approve or deny the request on that basis.

5.81 We would implement this option through a licence condition requiring compliance with coordination procedures.

5.82 This option should be effective in ensuring the PFD limits are respected. However, it would likely cause additional burden to Ofcom and to licensees.

Licensees carry out the coordination

5.83 This would mean requiring licensees to carry out their own coordination, on the basis of coordination parameters set by Ofcom. It would be implemented through a licence condition[104] requiring compliance with coordination procedures (see a draft licence at Annex A9). This reflects the similar approaches to coordination that we use in the 2.6 GHz, 3.4 GHz and 2.3 GHz bands.

5.84 We have taken into account Vodafone's submission that this option would require coordination between licensees if there were to be more than one winner of this block of spectrum. However, we do not consider that this would be necessary because the PFD limits we are proposing (which we have taken from ECC Report 299) account for multiple channels to be in use, meaning that any licensee transmitting up to the allowed limit would not result in a combined PFD sufficient to cause interference to satellite services.[105]

5.85 We therefore consider that this option would ensure that the required PFD limits are respected, while also enabling licensees to deploy without reference to Ofcom, in the manner BT/EE, VMO2 and the GSMA have told us would be most appropriate.

Viasat carries out the coordination

5.86 Viasat proposed that award winners should be required to provide their deployment information and coordination calculations to Viasat, and Viasat would provide feedback on deployments. We do not consider this would be an appropriate option: it imposes an additional burden on both award winners and Viasat, without giving rise to additional

[104] See condition 16 of the draft coordination procedure at Annex A10.
[105] See ECC Report 299, Annex 2, Table 13

spectrum efficiency or protection to satellite receivers. It may also raise the risk of regulatory disputes arising between operators with different incentives and could require an MNO to share market sensitive information about its deployment plans with Viasat.

Coordination calculations

5.87 As explained in Section 7, we propose to require licensees to keep records of their coordination calculations, and to make them available to Ofcom on request (see condition 16 of the draft coordination procedure at Annex A10).

5.88 We note that there will be areas close to more than one port and/or airport, and so they will fall into more than one coordination zone. For deployments in these areas, we propose to require that separate coordination calculations are performed for each of the affected PFD limited zones.

5.89 We propose that licensees should carry out coordination calculations between the position and height of the proposed deployment to the closest point on the perimeter of the corresponding PFD limited zone, at a receiver height of 10m. This represents our provisional view of the approximate height of satellite antennas on the top of the fuselage of a passenger jet when it is on the ground, as well as an approximation of the height of a ship.

5.90 As set out in paragraphs 5.35-5.39 above, our modelling shows that deployments based on 'small cell' parameters require much smaller coordination zones than deployments at maximum power with 'large cell' parameters. As a result, we propose to specify in the coordination procedures that if a deployment meets all of the 'small cell' deployment parameters shown in Table 5.3, then licensees can deploy on the basis of smaller coordination zones.

Conclusion and next steps

5.91 In summary, we propose to define:

a) PFD limited zones, defined as complex polygons, around the areas which we propose to protect as set out in Section 3. Within these zones, new licensees of 1492-1517 MHz will be required to ensure their deployments meet the PFD Limits set out in Table 5.1.
b) Coordination zones around these PFD limited zones within which new licensees will be required to coordinate new deployments to ensure the PFD limits within the PFD limited zones are met. We propose that coordination zones are defined as:
    i) protected airports: polygons describing a fixed range around the PFD limited zone; and
    ii) protected ports: no specific coordination zones are proposed at Phase 1, and then either polygons or a series of 1 km grid squares are proposed at Phase 2.

5.92 We propose that the new licensees of the spectrum should carry out this coordination.

Consultation questions

Question 8: Do you agree with our proposed approach to coordination?

Question 9: Do you agree with our proposal to define PFD limited zones as complex polygons? Would defining them as a set of points, rather than an entire boundary, make coordination calculations easier for licensees?

Question 10: Do you agree with our provisional view that not defining coordination zones around ports may be simpler for licensees than complying with multiple different coordination zones, particularly while Phase 1 PFD limits are in place?

Question 11: Do you have any feedback on the coordination procedures (as set out in Annex A10) or the specific parameters proposed?

Question 12: How difficult would you find it to comply with our proposed coordination requirements? In particular, we are interested in information from potential licensees on how the proposed coordination zones would affect their deployment processes and decisions.

Question 13: Do you have any comments on our proposal that licensees should carry out their own coordination, on the basis of coordination parameters set by Ofcom?

6. Technical licence conditions

Summary

6.1 In this section, we explain the technical licence conditions we propose to include in licences authorising use of the upper block of the 1.4 GHz band. Our proposals are based on:

a) the conditions set out in EC Decision 2018/661[106] (which amends EC Decision 2015/750); combined with
b) the example PFD limits for base stations transmitting multiple channels as set out in Annex 2, Table 13 of ECC Report 299, which suggests measures to address potential blocking of Mobile Earth Stations ("**MES**") operating in bands adjacent to 1518 MHz.

6.2 We are proposing equivalent isotropic radiated power ("**EIRP**") limits of 68 dBm/5 MHz in the 1492-1512 MHz block and 58 dBm/5 MHz in the 1512-1517 MHz block as given in ECC Decision 17(06). We consider that the reduced EIRP for the top 5 MHz block would help to ensure coexistence between mobile base stations and satellite services operating in the 1518-1559 MHz band.

6.3 To ensure coexistence with other licensees and adjacent band users, we are also proposing to require licensees to comply with out-of-band emission limits of -0.8 dBm/1 MHz for the 1518-1520 MHz band and -30 dBm/1 MHz for 1520-1559 MHz. These limits are set out in ECC Recommendation 17(06).[107]

6.4 In Section 5 we proposed to adopt the power flux density ("**PFD**") limits from Table 13 of ECC Report 299 within limited zones around ports and specific airports. These PFD limited zones would be surrounded by coordination zones, within which licensees would be required to coordinate new mobile base station installations to ensure that PFD limits are not exceeded within the limited zones. The proposed PFD limits are defined in two distinct phases, '**Phase 1**' and '**Phase 2**'.

6.5 For the protection of MSS on board aircraft, we propose to require compliance with two different sets of PFD limits at some airports. The more stringent Phase 1 PFD limits would be in place initially. At a later date, we propose to replace these with more relaxed Phase 2 PFD limits.

6.6 We propose that coordination around protected airports will be required within defined coordination zones whilst Phase 1 PFD limits apply, with reduced size coordination zones defined for lower power and lower height deployments. When Phase 2 PFD limits apply, the coordination zones around protected airports will be further reduced. Further details of PFD limited zones and their associated coordination zones are provided in Section 5.

[106] We consider it appropriate to authorise use of the upper 1.4 GHz band on the basis of technical conditions reflecting the EC Decision (to which the UK has contributed) because the adoption of harmonised conditions is likely to facilitate efficient spectrum use.
[107] ECC Recommendation 17(06) Table 7.

6.7 For the protection of MSS on board ships, we also propose to require compliance with the Phase 1 and Phase 2 PFD limits at ports. Phase 1 limits will apply from the award of the spectrum, with Phase 2 limits adopted at a later date.

6.8 We have proposed some different options for coordination around ports based on a simple range or coordination areas defined by polygons or a list of grid squares. These are described in more detail in Section 5. We propose that coordination zones around ports will also reduce in size for lower power and lower height mobile deployments and will be reduced further when Phase 2 PFD limits are adopted.

Background

6.9 The 1492-1517 MHz band has been harmonised for mobile supplemental downlink ("**SDL**") in the EU.[108]

6.10 Some satellite services in 1518-1559 MHz may be susceptible to interference from mobile base stations in the 1492-1517 MHz band, with older satellite receivers being less resilient to interference from the adjacent band. It is expected that these older, less resilient receivers will be phased out in the future, which is something we want to encourage.

Call for inputs proposals

6.11 In the October 2023 Call for Inputs ("**CFI**"),[109] we proposed to follow the recommendations in ECC Decision (17)06 and ECC Report 299 to allow for implementation consistency with other countries.

6.12 In accordance with ECC Decision (17)06, we proposed to require licensees to comply with maximum EIRP limits of 68 dBm/5 MHz and 58 dBm/5 MHz for the 1492-1512 MHz and 1512-1517 MHz bands respectively.

6.13 Additionally, we proposed to adopt the PFD limits set out in ECC report 299[110] in a phased approach and apply them at limited zones around ports and airports. The phased approach would allow us to revise the more stringent Phase 1 limits to the less stringent Phase 2 limits as older satellite terminals are replaced by newer terminals, which are less susceptible to interference.

6.14 We also proposed coordination zones around each port and airport in which new mobile base stations would be required to demonstrate that they would not exceed the PFD limits within the defined PFD limited zones. We discuss coordination zones in Section 5.

High level summary of call for inputs responses

6.15 Responses to the CFI fell into two categories:

[108] See EC Decision 2018/661, which amends EC Decision 2015/750.
[109] Ofcom, October 2023 CFI, para 3.30. .
[110] ECC Report 299, Table 13.

a) The International Mobile Telecommunications ("**IMT**") community, which consisted of the mobile network operators ("**MNOs**") and GSMA. These stakeholders acknowledged the need to protect the incumbent satellite services in the adjacent band but noted that this would cause significant restrictions to mobile deployments. As such, they generally encouraged us to try to reduce the restrictions on mobile use of the band.[111]
b) The Mobile Satellite Services ("**MSS**") community, consisting of Viasat, the Maritime and Coastguard Agency ("**MCA**"), and John Shaw. These stakeholders expressed that aside from blocking, we should consider the additional impacts of mobile on MSS, and accordingly they suggested that we should impose more stringent out-of-band emissions limits, greater protections and/or a slower move to Phase 2.[112]

PFD limits

6.16 Stakeholders generally agreed on the need for protection measures for MSS terminals. Viasat commented[113] specifically on the proposed PFD limits from ECC Report 299, suggesting that the PFD limits should be adjusted to account for high gain MSS receiver antennas as proposed in ITU-R M.2159.[114] This is discussed further in paragraph 5.21.

6.17 Stakeholders expressed differing views on the timeframe for moving from Phase 1 to Phase 2:

a) BT/EE, Vodafone and the GSMA argued that the Phase 2 limits should be relaxed sooner (within 5-7 years as suggested by ECC Report 299) in order to reduce the impact on future mobile deployments.[115] H3G, while requesting a balanced solution that minimised the impact on mobile use, did not provide a specific view on timelines for the relaxation of limits.[116] VMO2 considered that the 5-7 year timeframe would be "optimistic" due to the long lifecycle of equipment on ships and aircraft.[117]
b) In contrast, the MSS community argued for the more stringent Phase 1 limits to remain in place for either upwards of 15-25 years due to the equipment lifecycle,[118] or until there is evidence of a significant uptake of newer terminals.[119]

Power limits

6.18 Vodafone suggested that further coexistence analysis should be carried out with typical characteristics which were more reflective of UK deployments. It advised that the typical deployment of its equipment in the 1.4 GHz band operates at a median EIRP [CONFIDENTIAL

[111] BT/EE, CFI response, p. 4, Q. 1; H3G, CFI response, p. 9; VMO2, CFI response, p. 2, Q. 2.; Vodafone, CFI response, p. 2, Q. 1, and p. 3, Q. 2-3; GMSA, CFI response, p. 2.
[112] Viasat, CFI response, p. 6, Q. 1; MCA, CFI response, pp. 1-2, Q. 1; Shaw J, CFI response, p. 1, Q. 1.
[113] Viasat, CFI response, p. 8, Q. 1 (part IV).
[114] ITU, Recommendation ITU-R M.2159 (12/2023) .
[115] BT/EE, CFI response, p. 5, Q. 5; Vodafone, CFI response, p. 2, Q. 1, and p.3, Q2-3; GMSA, CFI response, p. 2.
[116] H3G, CFI response, p. 9.
[117] VMO2, CFI response, p. 4, Q. 5.
[118] MCA, CFI response, p. 6, Q. 5; Shaw J, CFI response, p. 8, Q. 5.
[119] Viasat, CFI response, p. 11, Q. 5.

✂] lower than the 68 dBm/5 MHz limit that we proposed between 1492-1512 MHz.[120] Conversely, H3G considered that power throughout the band should be consistent at 68 dBm/5 MHz and disagreed with our proposal that the EIRP limit should be reduced 10 dB to 58 dBm/5 MHz in the top 5 MHz of the band (1512-1517 MHz). H3G also noted that, as we had already proposed to impose coordination requirements on new mobile deployments, additional restrictions on power levels would not be necessary.[121]

Out-of-band emissions

6.19 Viasat commented that Ofcom should limit the out-of-band emissions ("**OOBE**") EIRP to -41 dBm/MHz.[122] This was due to a shared concern with the MCA and John Shaw about the coexistence analysis only considering blocking and not the effects of OOBE.[123] John Shaw further suggested that a 5 MHz guard band should have been considered to mitigate the effects caused by out-of-band emissions.

Our revised proposals

General technical licence conditions

PFD limits

6.20 We continue to consider it appropriate to adopt the PFD limits suggested in Table 13 of ECC Report 299, noting that stakeholders generally supported them.[124] As discussed in paragraph 5.21, we have considered the additional PFD limits given in Recommendation ITU-R M.2159, but consider that these are unnecessarily restrictive.

6.21 Our view also remains that taking a phased approach to these PFD limits (as described in ECC Report 299) is most appropriate for protected ports and airports. We propose that the more stringent Phase 1 limits should be in place until a date at which most older and more susceptible terminals are likely to have been replaced by new terminals which are more resilient to interference. The Phase 1 limits would then be replaced by the more relaxed Phase 2 limits.

6.22 As set out in Section 3, we propose to adopt Phase 1 PFD limits immediately for protection of both ports and international airports, moving to Phase 2 limits at a later date. These limits are presented in Table 6.1, expressed as the maximum permitted PFD per 5 MHz bandwidth. We propose to require licensees to comply with them at PFD limited zones around specific airports and ports, as highlighted in Section 5.

[120] Vodafone, confidential CFI response, p. 2, Q. 1.
[121] H3G, CFI response, p. 10.
[122] Viasat, CFI response, p. 6, Q. 1.
[123] MCA, CFI response, p. 1, Q. 1; Shaw J, CFI response, pp. 1-2, Q. 1.
[124] The limits are given for mobile base stations transmitting throughout the whole of the 1492-1517 MHz band.

Table 6.1: Phased PFD limits for base stations transmitting across multiple channels to be applied at protected ports and airports.

	PFD Limits (dBW/m^2 per 5 MHz)		
Frequency Band		1492-1512 MHz	1512-1517 MHz
Airports	Phase 1	-59.5	-63.4
	Phase 2	-36.9	-40.9
Ports	Phase 1	-80.9	-85.9
	Phase 2	-36.9	-40.9

Timescales

6.23 Over time, we expect older satellite terminals, which are more susceptible to interference from use of adjacent bands, to be replaced by more resilient terminals allowing for protections to be relaxed and PFD limits to be reduced. Phase 1 limits are more stringent and are intended to provide adequate protection for the most susceptible satellite terminals currently in operation.[125] Phase 2 limits are more relaxed and are intended to provide adequate protection for more resilient terminals. Our proposal for the timescale of Phase 2 limits replacing Phase 1 limits discussed in paragraphs 3.91-3.100.

Transmit power limits

6.24 We also propose the same in-block power limits as those we used for our coexistence analysis in the CFI. The values, as shown in Table 6.2 below, were recommended in Annex 2 of ECC Decision (17)06 as the least restrictive technical conditions for the deployment of mobile systems in this band.

Table 6.2: Maximum in-block EIRP per cell for specific frequency ranges, as recommended by ECC Decision 17(06)

Block frequency range	Maximum in-block EIRP per cell
1492-1512 MHz	68 dBm/5 MHz
1512-1517 MHz	58 dBm/5 MHz

6.25 We note that H3G is concerned about the top 5 MHz block having a lower EIRP limit, which it states would be unnecessary due to the coordination requirements imposed, and also severely restrict the power at which an MNO can transmit if they were to acquire the top 10 MHz of the band. However, we have conducted further analysis which indicates that the coordination distances would be up to three times larger if an EIRP of 68 dBm/5 MHz were to be used in the 1512-1517 MHz band. Given that the larger coordination zones around all protected areas would be impractical, we still consider it appropriate to apply the EIRP limits

[125] Based on the results of the terminals tested in ECC Report 299.

set out in ECC Decision 17(06). We note that we may review this EIRP limit again in the future, to see if it could be increased.

6.26 Vodafone commented that we should consider analysis with parameters which are more reflective of typical UK deployments. We have since conducted further analysis using what we consider to be more typical parameters which generate smaller coordination zones as highlighted in Section 5. Our coordination zones have been derived based on the worst-case parameters. Should a base station satisfy all the characteristics of a 'small cell' deployment, licensees would then be able to deploy on the basis of smaller coordination zones.

Additional limits

Out-of-block power limits

6.27 Block edge masks define the out-of-block emission limits for a given frequency range relative to the edge of a block of awarded spectrum to ensure coexistence with other licence holders in the band. The out-of-block emission limits we are proposing to implement align with those recommended in ECC Decision (17)06 and EC Decision 2018/661, and are set out in Table 6.3 below.

Table 6.3: Block edge masks for mobile base stations

Frequency range	Maximum out-of-block EIRP per cell
0-5 MHz from edge of block	16.3 dBm/5 MHz
5-10 MHz from edge of block	11 dBm/5 MHz
Frequencies >10 MHz from edge of block within band	9 dBm/5 MHz

Emissions falling into the MSS band

6.28 While out-of-block emissions limits help to ensure coexistence with other licence holders in the band, out-of-band emission ("**OOBE**") limits are used to ensure coexistence with users in the adjacent band.

6.29 Viasat, the MCA and John Shaw expressed concern that our coexistence analysis in the CFI did not consider out-of-band emissions. Additionally, Viasat commented that we should consider imposing a maximum out-of-band emissions EIRP limit of -41 dBm/1 MHz. We confirm that out-of-band emissions have been included in our analysis, which shows that interference from blocking is more significant than that from out-of-band emissions. This means that the more stringent out-of-band emissions limit requested by Viasat would have limited effect, as the distance at which interference may occur is determined by the impact of blocking, rather than the out-of-band emissions limits. As a result, we do not consider it is necessary or proportionate to impose more stringent out-of-band emissions limits, as proposed by Viasat.

6.30 John Shaw suggested that a 5 MHz guard band should have been considered to mitigate the effects caused by out-of-band emissions. We propose to adopt the reduced EIRP in ECC Decision 17(06) and the lower PFD limits given in ECC Report 299 in the 1512-1517 MHz part of the band. These allow the full 25 MHz band to be used efficiently, while affording

protections for the MSS services in the band above. Our analysis shows that potential for interference due to out-of-band emissions with an OOBE limit of -30 dBm/1 MHz is less than the potential for receiver blocking with these mitigations in place.

Table 6.4: Out-of-band emissions

Frequency range	Maximum out-of-band EIRP
1518-1520 MHz	-0.8 dBm/1 MHz
1520-1559 MHz	-30 dBm/1 MHz

Antenna elevation and height limits

6.31 As we are proposing to apply the PFD limits in Table 5.2 to limited zones, we do not think an antenna elevation restriction is necessary. Base stations operating within the coordination zones would be required to ensure compliance with the PFD limits, while base stations operating outside of the coordination zones would be unlikely to cause interference to satellite terminals.[126]

Coordination

6.32 We propose to require licensees to undertake coordination within coordination zones to ensure that PFD limits are met within limited zones. Further information on coordination is set out in Section 5.

Cross-border coordination

6.33 As the 1492-1517 MHz band is harmonised for mobile supplemental downlink in EC Decision 2018/661, we envisage the development of coordination agreements with the Republic of Ireland and with France, including any necessary provisions for the Channel Islands and the Isle of Man.

Consultation questions

Question 14: Do you have any comments on our proposed technical licence conditions?

[126] Coordination zones are defined to be cautious and consider the commonly occurring worst-case conditions, therefore the interference power at the satellite terminals due to base stations operating outside of coordination zones are likely to be below the allowed limits.

7. Non-technical licence conditions

Summary

7.1 This section sets out the non-technical licence conditions which we propose to include in the new 1.4 GHz licences. In summary, most of the conditions we propose below would be in line with Ofcom's standard non-technical licence conditions for mobile licences, as well as the existing 1.4 GHz licences which are already allocated to Vodafone and H3G. However, we note the following key differences between our proposed new 1.4 GHz licences and H3G and Vodafone's existing centre block licences:

a) the new licences include provision for payment of a lump sum fee at auction;
b) the new licences do not include any conditions relating to the avoidance of undue interference to fixed links operating in the 1.4 GHz band[127] (as the licences authorising these links would have all been revoked before the new 1.4 GHz licences are granted); and
c) the new licences include a condition requiring licensees to keep records of how they have demonstrated compliance with coordination procedures, and make these records available to Ofcom on request.

7.2 Annex A9 of this document includes an example of the proposed new licences, incorporating the proposals in this section.

Licence commencement

7.3 We propose that the award licences will commence on the date they are issued, shortly after the award.

Licence duration

7.4 When determining licence duration, we aim to strike a balance between ensuring licensees have sufficient long-term certainty for investment and maintaining ongoing efficient use of spectrum.

7.5 With this in mind, we have considered two broad options with regards to licence duration:

a) **Indefinite licences with an initial term** during which the licences cannot be revoked.

b) **Fixed term licences**, e.g. with a term of 10, 15, or 20 years, after which we would reallocate the spectrum.

[127] Schedule 1, paragraph 4 of the existing licences.

7.6 Typically, the spectrum licences we have awarded by auction[128] for mobile bands have been indefinite licences, with a 20-year initial term during which Ofcom cannot revoke the licence for spectrum management reasons. Ofcom may charge annual licence fees after the end of the initial term. Indefinite licences can provide a high level of investment certainty to prospective bidders, which mobile network operators ("**MNOs**") have told us that they consider can result in efficient use of spectrum.

7.7 We took a different approach to the duration of the mmWave licences that we will award via auction, opting for 15-year fixed term licences instead.[129] In deciding this, we noted in particular that the initial allocation may not reflect the most efficient allocation of mmWave spectrum in the longer term, due to the emerging potential of new uses for mmWave spectrum. Awarding fixed term licences enables Ofcom to address potential inefficiency, by reallocating the spectrum at the end of the fixed term.

7.8 We propose to award indefinite licences with an initial term for 1492-1517 MHz spectrum, in line with the approach taken in other awards. This is because the 1.4 GHz band has been harmonised internationally for supplementary downlink (**SDL**) mobile services. The centre block of this band is already used for this purpose, which means that the use cases are relatively certain and expected to remain stable in the medium term.[130] As a result, an inefficient allocation at the end of the term is less likely in the case of the 1.4 GHz band than it could be in the case of mmWave licences.

Duration of the initial term

7.9 We have considered whether an initial term of 10, 15 or 20 years would be most appropriate in this case. We consider the duration of the initial term should balance the need for investment certainty (which MNOs have told us points to a longer initial term), against the ability for Ofcom to revoke the licences if Ofcom considers it necessary.

Our proposal

7.10 We propose to award **indefinite licences with an initial term of 20 years**. This is because, as set out above, we consider that an inefficient allocation of these licences is unlikely to occur in the medium term, and, as such, we consider it appropriate to prioritise investment certainty for licensees in this case.

Alternative approach: bidders bid for annual licence fees

7.11 In the context of this award, we considered whether it could be appropriate to design the licences so as to facilitate trading between holders of the new licences in the upper block of the 1.4 GHz band, and existing licensees in the centre of the 1.4 GHz band (H3G and Vodafone). This is because H3G and Vodafone are already licensed to use the centre block of the band, but, due to their current locations, only H3G could secure contiguous spectrum

[128] These auctions include the 2021 award (700 MHz and 3.6-3.8 GHz), the 2018 award (2.3 GHz and 3.4-3.6 GHz) and the 2013 award (800 MHz and 2.6 GHz).
[129] Ofcom, September 2023 Statement on mmWave spectrum, Section 6.
[130] Commercial mobile has been a stable, high value of low frequency spectrum over multiple decades globally, and MNOs are highly dependent on this spectrum for their mobile networks.

after this award without a trade. We consider that an efficient allocation of this band is likely to entail all licensees holding contiguous blocks of spectrum.

7.12 One way to facilitate such trading might be to align the terms of the new and existing licences, with regard to their duration and fee payment mechanism. The initial terms of the existing 1.4 GHz mobile licences have already expired, meaning that the licences are now liable for annual licence fee ("**ALF**") payment, and Ofcom can revoke the licences for spectrum management reasons.

7.13 We have therefore considered whether it might be appropriate to take a novel approach to licence duration in this context, and award licences which have **no initial term, and are subject to ALFs from the start of their term.** This would mean that in the auction, operators would bid for an ALF, and pay this annually from the commencement of the licence, instead of paying a lump sum after the auction. The licences would be revocable from commencement (with five years' notice), and licensees could hand back the licence at any point.

7.14 In the near term, this could help to facilitate trading within the band, which could increase the likelihood that licensees obtain contiguous spectrum across the 1.4 GHz band. Facilitating trading within the band could also help to address any potential future inefficiency in the allocation.

7.15 However, we have identified a number of potential downsides to this novel approach:

a) It may reduce licensees' investment certainty, as Ofcom would have the power to revoke the licences with five years' notice from the date of issue.
b) The existing and new licences would likely be unaligned in other ways – e.g. we have proposed requirements in the 1492-1517 MHz licence(s) to protect adjacent band users, which the existing licences do not include. This suggests that while this approach could simplify prospective trades, there would be other, more significant barriers to trading. Therefore, this amendment would likely not be the determining factor in whether a trade occurs.
c) It could distort bidding incentives in the auction in the following ways:
    i. Incumbent licensees' bidding incentives could be dampened, because there could be an expectation of a more direct link between higher auction prices and the ALFs they will pay on their existing holdings in the band.
    ii. It could encourage risky or unfunded bidding in the auction because the winning licensee would only be committed to paying the fee for one year.

7.16 Therefore, we do not propose to take this approach to the duration of the new 1.4 GHz licences, but we are nonetheless interested in stakeholders' views on it.

Territorial extent of licences

National licences

7.17 We propose to award the licences for this spectrum on a UK-wide basis. They will not extend to the Channel Islands and the Isle of Man. This is consistent with other mobile licences we

have awarded, including recently in the 3.4-3.6 and 3.6-3.8 GHz bands, awarded after the 2018 and 2021 auctions.

7.18 We considered whether we should instead award local or regional licences. However, we have provisionally concluded that awarding national licences would be most likely to achieve optimal use of the spectrum. This is because the propagation characteristics of 1.4 GHz spectrum make it particularly suitable for providing wide area coverage, and we therefore expect the MNOs would deploy it widely to aid their provision of national mobile services. We think that the most efficient way to meet this demand will be through a UK-wide award of national spectrum licenses, allowing the MNOs and/or other bidders to offer UK-wide services.

Coordination and PFD Limited Zones

7.19 As set out in Section 3 of this document, we propose that use of these licences will be restricted in certain areas which we propose to define as coordination and power flux density ("**PFD**") limited zones.

7.20 We propose to require licensees to keep records of their coordination calculations, and to make them available to Ofcom on request, for future verification purposes.

The payment of licence fees

7.21 If we go ahead with our proposal to award licences with an initial term of 20 years set out in paragraph 7.10 above, we propose to include provision that would enable Ofcom to impose an on-going annual fee after the expiry of the initial period.

7.22 The mechanism and level of annual fees after the initial licence term would depend on our general approach to the use of this spectrum at the time, and how that general approach relates to these licences and to our statutory duties. Prior to any imposition of fees, we would consult as appropriate and give notice of our specific proposals.

Trading and Leasing

Trading

7.23 We propose to make the award licences tradable by amending the Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011 (the "**Mobile Trading Regulations**") to include the spectrum we are awarding.

7.24 This amendment would enable licensees to trade the rights and obligations under their award licences, with consent from Ofcom. Before giving consent to a trade, Ofcom may consider whether competition is likely to be distorted as a result of the trade. Further detail on this transfer process is provided in our "Trading Guidance Notes".

7.25 We plan to give formal notice of our proposals for amending the Mobile Trading Regulations, including the draft regulations that we propose to make to amend these regulations, later this year.

Leasing

7.26 We do not propose to make the award licences leasable. This is because we consider that the potential benefits of leasing could be achieved through use of Ofcom's Local Access licensing framework, or through trading. This position is in line with our approach to other licences covered by the Mobile Trading Regulations.

Non-technical restrictions on use

7.27 We do not propose to include any non-technical restrictions in the licences which would limit the use of spectrum (such as specifying the type of service that should be offered, the technology that should be deployed or the equipment that should be used).

Spectrum sharing

7.28 We note that the award licences will not guarantee exclusive use of the spectrum awarded. In the future, we may grant additional authorisations to allow the use of all, or part, of the spectrum, including the spectrum that is the subject of this consultation and statement. In particular, we propose to allow other users to access this spectrum through our Local Access licensing framework.

Local access licensing

7.29 Our Local Access licensing framework provides a way for other users to access spectrum which has already been awarded, in locations where the awarded licensee is not using the spectrum.

7.30 Local Access licensing allows access to spectrum without the need to enter into a commercial agreement with the existing licensee. Rather, following the process set out in Ofcom's Local Access Licence Guidance, the potential user makes an application to Ofcom to access for up to three years the spectrum held by someone else. This is a mitigation against the potential risk of spectrum lying fallow for periods of time, if it is not being used by the licensee in particular areas.

Roaming

7.31 We do not propose to include any roaming obligations in licences for this spectrum. However, we do not rule out the possibility of looking to impose roaming conditions, as appropriate, in these licences in the future. Any future proposals would be subject to analysis and consultation at the time.

Roll-out obligations ("use it or lose it")

7.32 We have considered whether to include roll-out obligations and/or a 'use it or lose it' clause in the award licences. Such obligations would require licensees to make use of the relevant spectrum (or deploy specified services) within a specified time period, or risk revocation of the licences if these obligations are not met.

7.33 Although such conditions could help to ensure efficient use of spectrum, we do not currently propose to include such conditions, because:

a) We consider that if bidders bid in the auction truthfully and based on their intrinsic value for the spectrum (and we have designed the auction to incentivise this), then the award winner(s) should be those whose use of the spectrum creates most value from it, and will deploy in a manner consistent with achieving that value.
b) We have proposed to include coordination zones and PFD limited zones in some parts of the country to protect some Inmarsat satellite receivers in the adjacent band from interference. This may limit the extent to which licensee(s) are able to rollout using the frequencies, both geographically and in terms of the numbers of mobile sites. In this context, such an obligation may be less appropriate and/or more complex to design.
c) As set out in Section 3, paragraph 3.7, there are signs that the equipment ecosystem is starting to mature and rollout in the other 1.4 GHz frequencies is beginning to gather speed. This indicates that a rollout obligation is unlikely to be necessary to encourage licensees to make use of the spectrum.
d) Such conditions are also difficult to make workable in practice because of the problem of defining what constitutes 'use' and therefore what the trigger for a licence revocation would be.

Access and inspection

7.34 In accordance with our standard spectrum licence conditions, we propose that licensees would be required to permit any person authorised by Ofcom to have access to, and to inspect, the radio equipment specified in the licence at all reasonable times.

Modification, restriction and closedown

7.35 In line with our standard spectrum licence conditions, we propose to include a licence provision which would enable Ofcom to require that the radio equipment (or any part of it) be modified, restricted in use or temporarily or permanently closed down if: (i) a licensee breaches the terms of its licence; (ii) the use of radio equipment is or may be causing or contributing interference to the operation of other authorised radio equipment; or (iii) it appears necessary or expedient in the event of a national or local state of emergency.

Record-keeping and provision of information to facilitate optimal spectrum use

7.36 In line with our duty to ensure optimal use of spectrum, we propose to include a condition in the licences requiring licensees: (i) to compile and maintain accurate written records of certain details relating to the radio equipment (specified in the licence); (ii) to produce these records if requested by Ofcom; and (iii) to provide, on request, such general information regarding their equipment and use of frequencies, or the roll-out of their network, as Ofcom may reasonably request.

7.37 We note that we have powers under both the Communications Act 2003 (section 135 to 146) and the Wireless Telegraphy Act 2006 (sections 32 to 33) to require the provision of information in certain circumstances. However, we consider that there remains a benefit in requiring licensees to compile and maintain basic details relating to the radio equipment that they are using pursuant to the licence so that it is readily available in the event that it is needed, for example, in cases of alleged interference.

Consultation questions

Question 15: Do you have any comments on the non-technical licence conditions that we propose to include in the award licences?

8. Auction design

Summary

8.1 In this section, we set out our auction design proposals for the award of the upper block of the 1.4 GHz band. We have developed the proposals taking account of stakeholders' comments to the October 2023 call for input ("**CFI**").

8.2 We propose a sealed bid single round auction format, with a second price rule. Bidding would be conducted in a single round, with the highest value bid or highest value combination of bids selected as the winning bids. Winning bidders would then pay fees based on a second price rule.

8.3 We propose to present bidders with the five bidding options shown in Table 8.1.

8.4 We propose that reserve prices should be £1m per 5 MHz.

Introduction

8.5 As set out in Section 2, we are proposing to award 25 MHz of spectrum in the upper block of the 1.4 GHz band by auction. In the rest of this section, we describe our proposals in the following order:

a) options we set out in the CFI;
b) summary of stakeholders' responses;
c) our proposals relating to:
    i. auction format;
    ii. information policy;
    iii. reserve price;
    iv. deposit requirements; and
d) illustrative auction procedures.

Options we set out in the Call for Inputs

Lot structure

8.6 In the CFI,[131] we sought views on whether stakeholders considered the following options regarding lot sizes appropriate:

a) auction the 25 MHz as a single block; or
b) auction the 25 MHz in smaller lot sizes (for example, as 5 lots of 5 MHz each; or as two lots, one of 10 MHz and one of 15 MHz).[132]

[131] Ofcom, October 2023 CFI, p. 22.
[132] The 15 MHz lot would include the top 5 MHz (1512-1517 MHz) which is likely to be subject to restrictions, as set out in paragraphs 6.24-6.25.

Auction format

8.7 We also sought views on the following auction formats:[133]

a) Option (a) - A "**sealed bid single round auction format**". There would be a single round where bidders submit bids for packages of lots. Bidders are either awarded a package of lots for which they bid in its entirety or nothing at all. In addition, the bids submitted by bidders are mutually exclusive, meaning that only one bid from each bidder may win. The highest bid or highest combination of bids would be selected as the winning bids. Winning bidders would then pay fees based on a second price rule, which we considered would likely lead to the most efficient outcome in this auction format.

b) Option (b) - A "**multiple round ascending auction**". There would be multiple bidding rounds. In each round, Ofcom would announce lot prices and bidders would place bids specifying the number of lots they are willing to win at those prices. If total demand were to exceed supply at the end of the round, Ofcom would increase prices and run another round. Ofcom would repeat this process until there is no excess demand. A simple clock auction is an example of a multiple round ascending auction which Ofcom will use for awarding mmWave spectrum.[134]

8.8 We said that the main benefit of Option (a) is that it would be faster and operationally simpler than Option (b). In the CFI, we said that Option (a) would mean that there would be no need for auction software and there would only be a single round of bidding, which would simplify the process for bidders and Ofcom.

8.9 On the other hand, we said that the main benefit of Option (b) is that bidders would have access to more information, such as excess demand, at the end of each round than under Option (a), which could help bidders in updating their bidding strategies. In addition, there would be a lower likelihood of surprise outcomes in the auction because there would be multiple rounds of bidding, allowing bidders to update their understanding of excess demand and of the value of the spectrum.

Summary of responses to the Call for Inputs

Lot structure

8.10 BT/EE[135] and VMO2[136] said that we should auction the spectrum as a single block. On the other hand, H3G[137] and Vodafone[138] considered that smaller lot sizes would be more appropriate for this award.

8.11 Specifically, on lot structure:

[133] Ofcom, October 2023 CFI, p. 22.
[134] In this section, we use the terms clock auction and multiple round ascending auction interchangeably as the clock auction format would be our preferred multiple round ascending auction format.
[135] BT/EE, CFI response, p. 6.
[136] VMO2, CFI response, p. 4.
[137] H3G, CFI response, pp. 7-8.
[138] Vodafone, CFI response, p. 5.

a) BT/EE suggested auctioning the 25 MHz as a single block, as "spectrum blocks much less than this size are unlikely to have a strong business case […], even if the onerous coordination constraints […] did not exist".[139] BT/EE also argued that smaller lot sizes may present the type of technical and commercial challenges it has faced in relation to the awards for 1900 MHz and 2.6 GHz.
b) VMO2 suggested auctioning the 25 MHz as a single block, as there is not a great amount of spectrum available for the award.[140] According to VMO2, smaller lot sizes may exacerbate the value uncertainty for bidders, already caused by the coordination constraints, and lead to an inefficient allocation of spectrum.
c) H3G suggested auctioning the 25 MHz as 5 lots of 5 MHz each. According to H3G, "the efficient allocation of the spectrum is unknown, but could very plausibly involve several bidders winning spectrum […]."[141] H3G said that 5 lots of 5 MHz each would bring maximum flexibility by letting the auction determine the efficient allocation for the spectrum. Additionally, H3G thought that the aggregation risk associated with smaller lot sizes would be manageable by bidders were Ofcom to run a multiple round auction with full information on excess demand. Thus, the threat of aggregation risks "would [not] be sufficient justification for Ofcom to assign lots larger than 5 MHz".[142]
d) Vodafone suggested auctioning the 25 MHz as 5 lots of 5 MHz each, as "we cannot rule out that the auction results in spectrum being awarded to two (or more) bidders".[143] Additionally, Vodafone said Ofcom should introduce spectrum minimum requirements, to prevent a bidder from winning a single 5 MHz lot. If this were not possible, "Ofcom might consider having different lot sizes (e.g. 1x10MHz and 3x5MHz)".[144]

Auction format

8.12 H3G,[145] VMO2[146] and Vodafone[147] said spectrum should be auctioned via a multiple round ascending auction. On the other hand, BT/EE[148] considered a sealed bid single round auction format more appropriate for this award.

8.13 Specifically, on auction format:

a) BT/EE[149] suggested adopting a sealed bid single round auction format, as long as spectrum is auctioned as a single block, which is BT/EE's preference. However, if Ofcom were to adopt smaller lot sizes, then BT/EE would prefer a multiple round ascending auction to mitigate common value uncertainty.

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[139] BT/EE, CFI response, p. 6.
[140] VMO2, CFI response, p. 4.
[141] H3G, CFI response, p. 7.
[142] H3G, CFI response, p. 8.
[143] Vodafone, CFI response, p. 5.
[144] Vodafone, CFI response, p. 5.
[145] H3G, CFI response, pp. 6-7.
[146] VMO2, CFI response, p. 3.
[147] Vodafone, CFI response, pp. 4-5.
[148] BT/EE, CFI response, p. 6.
[149] BT/EE, CFI response, p. 6.

b) H3G said we should conduct a multiple round ascending auction and provide information about aggregate demand after each round. According to H3G, full information on excess demand would mitigate common value uncertainty and is more likely to lead to an efficient outcome. Although a sealed bid single round auction would be quicker to run, H3G said that "Ofcom must principally consider which auction format is more likely to result in the efficient allocation of spectrum, and put much less weight on a small difference in the auction duration".[150] Additionally, H3G argued that, if they were to win spectrum in the auction, Ofcom should automatically assign them the frequencies adjacent to their existing holdings, to guarantee contiguity.[151]

c) Vodafone suggested adopting a multiple round ascending auction. According to Vodafone,[152] a multiple round auction is more appropriate as (i) bidders can express their valuations and counterbid; (ii) bidders can bid on specific quantities of spectrum; and (iii) bidders are already familiar with the clock auction format.

d) VMO2 suggested adopting a multiple round ascending auction, such as a simple clock. According to VMO2,[153] a multiple round auction would enable price discovery, which VMO2 considered an essential feature of mobile spectrum auctions. VMO2 also thought a simple clock auction would mitigate the common value uncertainty due to the proposed coordination constraints.

Our proposals

High level assessment of options

8.14 Smaller lot sizes give bidders flexibility about the amount of spectrum to bid on and allow for multiple winners but may introduce aggregation risk. Aggregation risk arises when lots in the auction are complements to each other or to a bidder's current holdings, and the bidder risks winning lots which do not help to realise the synergies from holding the complementary spectrum.

8.15 On the other hand, auctioning the 25 MHz as a single block would eliminate the aggregation risk, as no bidder could win any smaller amount than the whole block, but at the expense of giving bidders flexibility on the amount of spectrum they bid for.

8.16 A key aim of our design is to maximise the opportunity for an efficient allocation of the spectrum. Some stakeholders have expressed interest in the whole 25 MHz block, while others have expressed interest in smaller holdings. We believe that it is important to provide opportunity for both types of strategy in the auction, so that bidding can determine the most efficient allocation of the spectrum.

8.17 In light of stakeholders' comments, we have considered the following criteria in developing proposals for the design of this auction:

[150] H3G, CFI response, pp. 6-7.
[151] H3G, CFI response, p. 8.
[152] Vodafone CFI response, pp. 4-5.
[153] VMO2, CFI response, p. 3.

i) flexibility in the quantities of spectrum that the auction process could allocate to winners;
ii) bidders' ability to manage aggregation risk;
iii) bidders' ability to target specific frequencies;
iv) opportunity for price discovery; and
v) avoiding unnecessary operational complexity.

8.18 We consider that an auction format that could deliver (i) to (iii), such as a combinatorial clock auction, would be disproportionately complex for this award, so we do not propose to examine it further.

8.19 We have considered three options in more detail:

- Option A: **simple clock auction with 5 lots of 5 MHz**, which would consist of two stages: a multiple rounds principal stage with ascending prices in which bidders bid for frequency-generic lots; and a single round assignment stage in which bidders bid for the precise frequency locations for the lots they won in the principal stage.
- Option B: **simple clock auction with a 10 MHz lot and a 15 MHz lot**. This would consist of only the principal stage as lots would be frequency specific, with the 10 MHz lot assigned frequencies 1492-1502 and the 15 MHz lot assigned frequencies 1502-1517 MHz. Bidders would therefore bid for both a spectrum amount and specific frequencies in the principal stage.
- Option C: **single round package auction**, in which bidders bid their values for the precise spectrum allocations they are interested in ("**spectrum packages**").[154] We would then select the combination of bids with the highest value, and use a second-price rule to determine the amount each winner would pay.
  We consider that such package auction would be best implemented in a sealed bid format[155] and would not be practicable in a multiple round sequential format (such as a clock auction).

Option A: Simple clock auction with 5 lots of 5 MHz

8.20 In the simple clock auction of Option A, we would award the spectrum as 5 lots of 5 MHz each. In terms of the criteria set out in paragraph 8.17, this format and lot structure would:

a) Allow flexibility for both types of bidding strategy sought by respondents.
b) Help those stakeholders interested in the whole 25 MHz block to manage the aggregation risk, through the inclusion of "all or nothing" bids in the principal stage.[156] However, we note that for these bidders a substantial aggregation risk would remain.
c) Bidders would bid for a generic amount of spectrum in the principal stage, and then bid in the assignment stage for the frequency location of any spectrum they won.
d) Offer opportunity for price discovery during bidding in the principal stage.

[154] In this document, spectrum packages are often referred to as "bidding options".
[155] In this document, when referring to a sealed bid single round auction format, we mean a sealed bid single round combinatorial auction.
[156] With an "all or nothing" bid, a bidder specifies that it wants to change its demand either by an exact amount of spectrum or not at all.

e) Entail a certain degree of complexity of the auction process.

Option B: Simple clock auction with a 10 MHz lot and a 15 MHz lot

8.21 In the simple clock auction of Option B, we would award the spectrum as frequency specific lots of 10 MHz (1492-1502 MHz) and 15 MHz (1502-1517 MHz). In terms of the criteria set out in paragraph 8.17, this format and lot structure would:

a) Allow flexibility for both types of bidding strategy sought by respondents, noting however that winning 5 or 20 MHz of spectrum would not be possible.
b) Help those stakeholders interested in the whole 25 MHz block to manage the aggregation risk by introducing larger lots than Option A, noting, however, that for these bidders a substantial aggregation risk would remain.
c) Bidders would bid for the frequency location of the spectrum at the same time as the amount.
d) Offer opportunity for price discovery during bidding.
e) Entail a certain degree of complexity of the auction process.

Option C: Single round package auction

8.22 Under this option, bidders would bid in a single round for a number of frequency specific packages, including but not limited to the whole 25 MHz block.

8.23 We understand that a package auction could cause complications for bidders, as bidders would need to form valuations on all packages available in the award. Thus, to reduce bidding and bid processing complexity (criterion (v) in paragraph 8.17), we have considered how to limit the number of packages to offer for bidding in this format.

8.24 To inform our provisional view of which packages we should make available to bidders in the auction, we first considered all possible packages of contiguous spectrum which would include one or more 5 MHz lots, and then removed those options which we think are unlikely to form part of an efficient allocation of spectrum (or be attractive to potential bidders). We set out the steps in our reasoning in full in Annex A14.

8.25 We provisionally conclude that we should offer the following five bidding options to each bidder (as shown in Table 8.1 below):

a) the lower 10 MHz;
b) the upper 15 MHz;
c) the whole 25 MHz block;
d) the lower 5 MHz; and
e) the upper 20 MHz.

Table 8.1: Proposed bidding options and winning outcomes for the award.

	MHz				
	1492 - 1497	1497 - 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option A1					
Option A2					
Option B3					

	MHz				
Option C4					
Option C5					

In this figure, the bidding options are indicated by the number, while the combinations of winning outcomes are indicated by the letter.

8.26 In terms of the remaining criteria set out in paragraph 8.17, this format and lot structure would:

i) Allow flexibility for both types of bidding strategy sought by respondents.
ii) Eliminate the aggregation risk[157] which may otherwise be faced by those stakeholders interested in the whole block.
iii) Bidders would bid for the location of the spectrum at the same time as the amount.

8.27 On criterion (iv) in paragraph 8.17, we recognise that a single-round auction would offer no opportunity for price discovery. We discuss this in more detail from paragraph 8.39 below.

Detailed assessment of options

8.28 Options A, B and C outlined above differ largely in terms of (i) flexibility in the quantities of spectrum, (ii) aggregation risk, (iii) bidders' ability to target specific frequencies, (iv) the extent of price discovery they enable, and (v) operational complexity.

8.29 We analyse these differences in detail below.

Flexibility in the quantities of spectrum

8.30 By flexibility, we mean the bidders' ability to bid for the quantity of spectrum they wish to.

8.31 We consider flexibility to be very important for this auction, as mobile network operators ("**MNOs**") have different existing holdings in the band and have expressed interest in different spectrum quantities.

8.32 Both options A and C allow for maximum flexibility, as the smaller lot size of Option A and the package structure of Option C let bidders flexibly choose the quantity of spectrum to bid for in multiples of 5 MHz.

8.33 On the other hand, the larger lot sizes in Option B would reduce a bidder's flexibility to bid for smaller quantities of spectrum. As a result, this could potentially eliminate options that may be part of the efficient allocation of the spectrum, such as C4 and C5 in Table 8.1.

Aggregation risk

A clock auction (options A and B) could carry aggregation risk

8.34 Typically, in a clock auction, the aggregation risk arises as bidders can only decrease their demand to the extent that doing so would not cause aggregate demand to fall below available supply (i.e. cause unsold spectrum). Thus, as a bidder's request to decrease

[157] When bidding on a certain package, the bidder would know that they would either win that package in its entirety or not at all.

demand by a certain number of lots may be refused or only allowed partially, that bidder may win a quantity of spectrum different from their desired amount.[158]

8.35 The degree of aggregation risk faced by bidders in a clock auction depends in part on the lot size. The aggregation risk is higher in Option A with 5 MHz lots as bidders would be at risk of winning a sole 5 MHz, whereas in Option B the minimum a bidder could win would be 10 MHz. Therefore, bidders who want a minimum of 10 MHz would face no aggregation risk in Option B but would face such a risk in Option A.

8.36 Nevertheless, both options carry aggregation risk for bidders that want to win only the entire 25 MHz block and have no value for any smaller amount of spectrum.

8.37 We note that full information on excess demand[159] could mitigate the aggregation risk to a degree for both options. The inclusion of all-or-nothing bids[160] could also mitigate aggregation risk for bidders in Option A.

A sealed bid single round auction (Option C) eliminates aggregation risk

8.38 In a sealed bid single round auction, bidders could select specific packages on which to bid, which they would win either wholly or not at all. Therefore, the ability to bid on specific packages eliminates aggregation risk.

Price discovery

8.39 Price discovery is the process through which bidders confirm and/or adjust their spectrum valuations by looking at excess demand information after each round.

8.40 Price discovery is only possible if the auction progresses over multiple rounds (Options A and B). There would therefore be no opportunity for price discovery during the auction in a sealed bid single round auction (Option C).

8.41 As detailed above, MNOs have indicated that price discovery would help them value the spectrum.

8.42 Below, we consider the benefits of price discovery in this auction.

Possible benefits of enabling price discovery in this auction:

8.43 We think that price discovery through the auction might bring some benefit because:

a) the restrictions on use of this spectrum required to protect adjacent band users (see Section 3) may mean some bidders may find it difficult to value this spectrum; and

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[158] For example, suppose that a bidder has a need for at least 10 MHz of spectrum and would prefer winning no spectrum at all over only winning 5 MHz. Also, suppose that, in a clock round, this bidder wishes to reduce its demand from 10 MHz to 0 MHz. However, if this demand reduction would cause unsold spectrum, its request would only be allowed partially, and the bidder would end up winning 5 MHz.

[159] By looking at excess demand, a bidder would be able to predict (to a certain degree) whether they are likely to win their preferred amount of spectrum and bid accordingly. Thus, following from the example set out in footnote 158, a bidder may decide not to reduce its demand, for fear of its bid not being fully accepted and the bidder ending up winning 5 MHz. Therefore, the bidder may continue to bid for 10 MHz at a higher price than its valuation.

[160] Following from the example set out in footnote 158, if that bidder had submitted an all or nothing bid to reduce its demand from 10 MHz to 0 MHz, and if this request could not be accepted fully, the request would be rejected and the bidder would maintain its 10 MHz, however at a higher price.

b) the 1.4 GHz band is used for SDL spectrum. As a result, BT/EE and VMO2, who do not already hold spectrum in the band, may find it beneficial to learn about the valuations of others who have already deployed 1.4 GHz.

Possible reasons price discovery may be less beneficial in this case than in other awards

8.44 However, price discovery may not be as beneficial to bidders for this award as it has been in previous awards, because:

a) Both Vodafone and H3G already hold licences to use 1.4 GHz spectrum, meaning they may already have a good sense of its value.
b) MNOs' existing holdings in the band are different: Vodafone and H3G already hold licences for frequencies in the band, while BT/EE and VMO2 do not. It is then possible that BT/EE and VMO2's values for new spectrum in the band may be different to H3G/Vodafone's values for increasing their holdings (in particular, given that their costs of deployment could differ). Thus, there would likely be little common value uncertainty as bidders may have significantly different spectrum valuations.
c) The characteristics of the 1.4 GHz band are already well known, unlike, for example, mmWave spectrum, so bidders should be able to use this information to form valuations outside the auction.

Bidders' ability to target specific frequencies

8.45 The ability to target specific frequencies may be important to bidders that already hold licences for spectrum in the 1.4 GHz band, and thus may want to acquire new spectrum which is adjacent or proximate to their existing holdings. For example, H3G has requested that Ofcom automatically assigns them (if they win spectrum in the award) the frequencies adjacent to those they are currently licenced to use.[161]

8.46 We consider that agreeing to this request may impact competition and distort bidding, by failing to consider other bidders' valuations for those specific frequencies. Nonetheless, we consider below whether either of the auction formats are likely to support an efficient outcome by allowing bidders such as H3G to target frequencies effectively.

Option A has generic lots, meaning bidders will not be able to target frequencies in the principal stage

8.47 In this award, it is plausible that the location in the band could constitute a large element of the overall valuation for at least some bidders. Such bidders may therefore bid under significant uncertainty in the principal stage of Option A, as specific frequencies would only be determined subsequently in the assignment stage. This could increase the risk of inefficient outcomes.

In options with frequency specific lots or packages (Options B and C), bidders can target frequencies

8.48 In Option B, the clock auction lots would have assigned frequencies of 1492-1502 MHz and 1502-1517 MHz. Similarly, in Option C, bidders would bid on the frequency specific packages outlined in Table 8.1 above. This means that a bidder would necessarily bid for specific

[161] H3G, CFI response, p. 8.

frequencies when bidding for the spectrum in both Options B and C. This could increase the likelihood of an efficient outcome.

Operational complexity

8.49 A clock auction (Options A and B) would require more time and resources to prepare and run and participate in. Prospective applicants may require some time to familiarise themselves with the auction process and software and Ofcom would need to hold a number of mock auctions, and to run training sessions for prospective applicants. When bidding commences, both Ofcom and bidders may need to be available for a considerable time period, as a clock auction may last for several rounds and days.

8.50 On the other hand, a sealed bid single round auction format (Option C) would be less time and resource intensive for bidders and for Ofcom as the auction would end in one round.

8.51 In addition, in the options with frequency specific lots (Options B and C), there would not be an assignment stage, making the auction simpler and faster than a clock auction with generic lots (Option A).

Summary of assessment of options

8.52 Below in Table 8.2 we give a visual representation of the trade-offs between the three options, although the text above is a more thorough and accurate reflection.

8.53 Table 8.2 highlights that the main advantages of each option are:

- Option A: Allows for price discovery as well as flexibility down to 5 MHz lots.
- Option B: Allows for price discovery and targeting of specific frequencies, as well as performing reasonably on all other metrics.
- Option C: Is flexible down to 5 MHz lots, eliminates aggregation risk, is operationally simple and allows for targeting of specific lots.

Table 8.2: Visual representation of the trade-offs between options

	(A) Clock - 5x5 MHz	(B) Clock 10/15 MHz	(C) Sealed Bid
Flexibility in quantity	✓✓	✓	✓✓
Manage aggregation risk	×	✓	✓✓
Target specific frequencies	✓	✓✓	✓✓
Price discovery	✓✓	✓✓	×
Operational simplicity	×	✓	✓✓

In this figure two ticks denotes that an option accomplishes the objective, one tick the option does reasonably well, and a cross is where that option scores poorly.

Provisional conclusion

8.54 Considering these factors about possible lot structure and auction formats, we propose to award this spectrum via a sealed bid single round auction, with a second price rule and the bidding options and outcomes shown in Table 8.1.

8.55 We consider this option to be the most appropriate because:

a) It gives bidders flexibility about lot sizes. It enables MNOs such as BT/EE and VMO2, who have expressed a preference for the entire 25 MHz available,[162,163] the opportunity to bid for Option B3 in Table 8.1. On the other hand, MNOs such as H3G and Vodafone would have the flexibility to bid for a smaller quantity of spectrum, down to 5 MHz, if preferred.
b) It would eliminate aggregation risk, as bidders would bid on specific packages and therefore would not face any risk of winning only a subset of what they have bid on.
c) It would be operationally and administratively simpler for both bidders and Ofcom. As there are few bidding options available, it should not be overly difficult or time consuming for bidders to determine the value of the packages available and participate in the auction, or for Ofcom to prepare and run the auction.
d) It would always enable bidders to target specific frequencies. For example, under our proposal, H3G would be able to directly target the bottom of the block (bidding options A1 or C4), if they so wish.
e) The benefits of price discovery are limited in this award. This is due to the well-known characteristics of 1.4 GHz spectrum and the likelihood of bidders having different valuations based on their existing asymmetric holdings in the band.

8.56 Taking all these factors into account, we consider that Option C is most likely to lead to an efficient allocation of spectrum without unduly complicating the award.

8.57 We welcome stakeholders' views on the proposed auction format and bidding options.

Information policy

8.58 In line with the approach that we have taken in previous auctions (such as the 2021 award of the 700 MHz and 3.4-3.6 GHz spectrum bands) and that we are planning to take with our upcoming mmWave auction, we propose to disclose the total number of qualified bidders and their identity before bidding starts.

8.59 At the end of the auction, we propose to release the following information to all bidders:[164]

a) the names of the winning bidders and the frequencies won by those bidders (and the licence fees paid);

[162] BT/EE, CFI response, p. 6.
[163] VMO2, CFI response, p. 4.
[164] Unlike many of our previous auctions, we plan to run the award in a single round. This meaning that we will not be releasing information about excess demand during the auction.

b) the names of those winning bidders (if any) that failed to pay their licence fee on time and who therefore failed to obtain licences in the auction, despite making winning bids; and
c) details of all winning and non-winning bids.

8.60 However, we understand that releasing details of all non-winning bids may pose a risk for those spectrum holders who may want to engage in trading afterwards. For this reason, although we are inclined towards full transparency, we welcome stakeholders' comments and views on the above.

Reserve prices

8.61 The reserve price is the minimum price for one lot.

8.62 Conservative reserve prices encourage entrants to participate in the award and reduce the risk of unsold spectrum. However, reserve prices that are too low could invite frivolous bids.

8.63 To inform our choice of reserve prices, we propose to use benchmarks of prices from auctions in other jurisdictions and set reserve prices which we think will be materially lower than possible market value.

Benchmarks for market value

8.64 To determine benchmarks for market value, we have identified six spectrum awards of 1.4 GHz spectrum. These auctions all took place in Europe, which we consider to be comparable to the UK.[165]

8.65 We have used prices from these awards to derive UK equivalent value benchmarks for 1.4 GHz spectrum. We applied a series of adjustments to these price benchmarks to control for cross-country variations. Our process was to consider:

a) If the payment was made in instalments, we calculate the present value of the payment.[166]
b) We make adjustments to reflect our minded position to have a 20-year award licence duration.[167]
c) We account for differences in purchase power parity of the relevant country and the UK at the time of the award.[168]

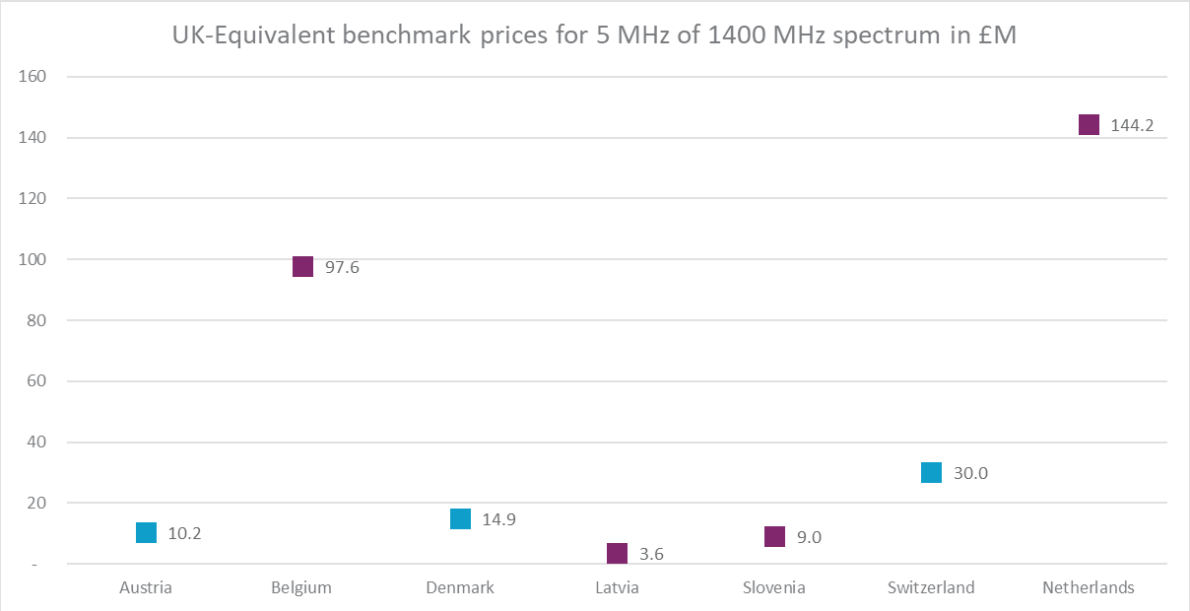
[165] While other European countries – besides the ones we have identified – have awarded the 1.4 GHz band, we have focused solely on those six countries which have awarded the specific 1.4 GHz frequencies we are interested in (1492 – 1517 MHz).
[166] The discount factor we use is the pre-tax nominal cost of debt, 3.6%, and the corporate tax rate, 19%. The pre-tax cost of debt is from Ofcom's Statement "Wholesale Fixed Telecoms Market Review 2021-26", annexes 1-26, table A20.1.
[167] For simplicity, we use the pre-tax nominal Weighted Average Cost of Capital ("**WACC**") for the mobile sector in the UK, 7.8%, and the corporate tax rate, 19%, as the discount factor. See Ofcom's Statement "Wholesale Voice Markets Review 2021–26", annex 1-4, p. 21.
[168] We use PPP conversion factors from the World Bank | World Development Indicators database, World Bank | Eurostat OECD PPP Programme.

d) We project the prices of the award to Q1 2026 prices, using UK CPI inflation between the date of the country's award until the expected date of our award.[169]
e) We account for differences in population between the award country and the UK population.[170]
f) We account for any delays between the auction date and the licence start date.[171]

8.66 Our methods may not account for other differences in spectrum values,[172] which are more difficult to address in a robust way.

8.67 We first consider the entire 1.4 GHz band (frequencies 1427 – 1517 MHz).[173] The results of our analysis are shown in Figure 8.1 below. In the figure, purple (Belgium, Latvia and Slovenia) denotes that spectrum lots were sold above reserve prices; and blue (Austria, Denmark and Switzerland) denotes that the reserve price was used to calculate the benchmark. In Austria and Denmark, we used the reserve price as the award for combinatorial, so band-specific prices would be difficult to derive accurately. In Switzerland, we used the reserve price as the award included multiple bands and the auctioneer did not disclose how much was paid for each band.[174]

Figure 8.1: 1.4 GHz (1427 - 1517 MHz) UK equivalent benchmark prices for 5 MHz based on Q1 2026 prices



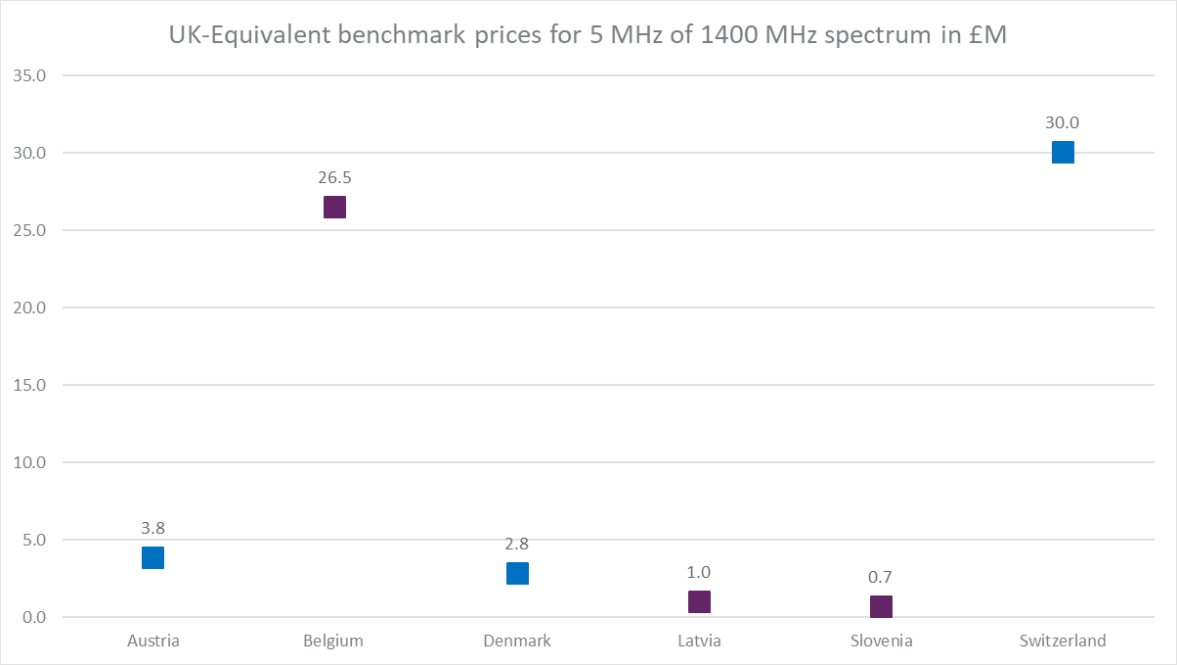
[169] We use CPI data and forecasts from the Office for Budget Responsibility.
[170] We use population data from the World Bank.
[171] For simplicity, we use the pre-tax nominal WACC for the mobile sector in the UK, 7.8%, and the corporate tax rate, 19%, as the discount factor. See Ofcom's Statement "Wholesale Voice Markets Review 2021–26", annex 1-4, p. 21.
[172] For example, the technology available to mobile network operators ("**MNOs**") may change across time periods and thus impact the spectrum value.
[173] Austria, Belgium, Denmark, Slovenia, and Switzerland awarded frequencies 1427 – 1517 MHz. Latvia awarded frequencies 1432 – 1512 MHz.
[174] Additionally, in Switzerland, frequencies 1427 – 1442 MHz went unsold.

8.68 Our results show that the average of the UK equivalent of all prices (calculated by applying the adjustments listed in paragraph 8.65) in the analysis is approximately £44.2m per 5 MHz lot. The range is from £3.6m to £144.2m.

8.69 We then consider solely the frequencies we are interested in for our award (frequencies 1492 – 1517 MHz), noting that the Netherlands has not auctioned this part of the 1.4 GHz band. The results of our analysis are shown in Figure 8.2 below. In the figure, the colours take the meaning described in paragraph 8.67.

8.70 Our results show that the average of the UK equivalent of all prices (calculated by applying the adjustments listed in paragraph 8.65) in the analysis for frequencies 1492 – 1517 MHz is approximately £10.8m per 5 MHz lot. The range is from £0.7m to £30.0m.

Figure 8.2: 1.4 GHz (1492-1517 MHz) UK – Equivalent benchmark prices for 5 MHz based on Q1 2026 prices



8.71 Overall, we interpret these international benchmarks with a degree of caution, because there are relatively few benchmarks available (especially when only considering the 1492 – 1517 MHz frequency range). We have focused on the lower end benchmarks in order to propose reserve prices that are likely materially lower than market values.

8.72 We therefore propose that the 1.4 GHz reserve price should be £1m per 5 MHz lot.

Deposit

8.73 We propose that, along with their application, applicants would be required to submit an initial monetary deposit which might be forfeited, in whole or in part, if the applicant subsequently breaches the award regulations. Any interest made by Ofcom while holding the deposits would be returned to the Consolidated Fund.

8.74 We will publish more information on the deposit requirements closer to the start of the auction.

Illustrative auction procedures

8.75 As part of our work on the proposed award process, Ofcom has drafted some illustrative procedures, set out in Annex A13. These are an initial draft and are being shared as part of this consultation so that stakeholders can obtain a more in depth understanding of our proposed design. The procedures are evolving, and it is quite likely that there will be changes especially when Ofcom commences work on implementing these processes into a statutory instrument. There are strict rules on the drafting of legislation, and it might well be that there are changes and adjustments to the processes that are necessary for that reason. Nevertheless, we considered it helpful to share our current thinking with stakeholders and we would welcome any comments and suggestions on this as part of our consultation exercise.

Consultation questions

Question 16: Do you have any comments on the proposed format for the auction?

Question 17: Do you have any comments on the proposed bidding options for the auction? Do you believe we have excluded any bidding options which would be worth identifying?

Question 18: Do you have any comments on our proposed information policy or reserve price?

A1. Responding to this consultation

How to respond

A1.1 If you would like to provide views and comments on the issues raised in this document, please provide these no later than 5pm on 25 April 2025.

A1.2 You can download a response form from https://www.ofcom.org.uk/spectrum/innovative-use-of-spectrum/call-for-input-1.4-ghz-band-available-for-mobile. You can return this by email or post to the address provided in the response form.

A1.3 If your response is a large file, or has supporting charts, tables or other data, please email it to 1.4GHz.authorisation@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet.

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

Spectrum Awards
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A1.5 We welcome responses in formats other than print, for example an audio recording or a British Sign Language video. To respond in BSL:

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

A1.6 We will publish a transcript of any audio or video responses we receive (unless your response is confidential)

A1.7 We do not need a paper copy of your response as well as an electronic version. We will acknowledge receipt of a response submitted to us by email.

A1.8 You do not have to answer all the questions in the consultation if you do not have a view; a short response on just one point is fine. We also welcome joint responses.

A1.1 It would be helpful if your response could include direct answers to the questions asked in the consultation document. The questions are listed at Annex A4. It would also help if you could explain why you hold your views, and what you think the effect of Ofcom's proposals would be. Comments based on hypothetical or potential scenarios are less helpful and less reliable than comments based on actual evidence or objective facts. Where available and possible, it would therefore be helpful if you could provide evidence to support your views.

A1.2 If you want to discuss the issues and questions raised in this consultation, please contact the 1.4 GHz Authorisation Team by email to 1.4GHz.authorisation@ofcom.org.uk.

Confidentiality

A1.3 Consultations are more effective if we publish the responses before the consultation period closes. This can help people and organisations with limited resources or familiarity with the issues to respond in a more informed way. So, in the interests of transparency and good regulatory practice, and because we believe it is important that everyone who is interested in an issue can see other respondents' views, we usually publish responses on the Ofcom website at regular intervals during and after the consultation period.

A1.4 If you think your response should be kept confidential, please specify which part(s) this applies to and explain why. Please send any confidential sections as a separate annex. If you want your name, address, other contact details or job title to remain confidential, please provide them only in the cover sheet, so that we don't have to edit your response.

A1.5 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and try to respect it. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.6 To fulfil our pre-disclosure duty, we may share a copy of your response with the relevant government department before we publish it on our website.

A1.7 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's intellectual property rights are explained further in our Terms of Use.

Next steps

A1.8 Following this consultation period, Ofcom plans to publish a detailed statement on our proposals for making the upper block of 1.4 GHz spectrum available.

A1.9 If you wish, you can register to receive mail updates alerting you to new Ofcom publications.

Ofcom's consultation processes

A1.10 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex A2.

A1.11 If you have any comments or suggestions on how we manage our consultations, please email us at consult@ofcom.org.uk. We particularly welcome ideas on how Ofcom could more effectively seek the views of groups or individuals, such as small businesses and residential consumers, who are less likely to give their opinions through a formal consultation.

A1.12 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact the corporation secretary:

Corporation Secretary
Ofcom
Riverside House

2a Southwark Bridge Road
London SE1 9HA
Email: corporationsecretary@ofcom.org.uk

A2. Ofcom's consultation principles

A2.1 Ofcom has seven principles that it follows for every public written consultation:

Before the consultation

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

During the consultation

2. We will be clear about whom we are consulting, why, on what questions and for how long.
3. We will make the consultation document as short and simple as possible, with an overview of no more than two pages. We will try to make it as easy as possible for people to give us a written response.
4. When setting the length of the consultation period, we will consider the nature of our proposals and their potential impact. We will always make clear the closing date for responses.
5. A person within Ofcom will be in charge of making sure we follow our own guidelines and aim to reach the largest possible number of people and organisations who may be interested in the outcome of our decisions. Ofcom's Consultation Champion is the main person to contact if you have views on the way we run our consultations.
6. If we are not able to follow any of these principles, we will explain why.

After the consultation

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

A3. Consultation coversheet

Basic details

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

Confidentiality

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

- Nothing ☐
- Name/contact details/job title ☐
- Whole response ☐
- Organisation ☐
- Part of the response ☐

If you selected 'Part of the response', please specify which parts:

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

Yes ☐ No ☐

Declaration

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

Ofcom aims to publish responses at regular intervals during and after the consultation period. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here.

Name Signed (if hard copy)

A4. Consultation questions

Please tell us how you came across about this consultation.

- ☐ Email from Ofcom
- ☐ Saw it on social media
- ☐ Found it on Ofcom's website
- ☐ Found it on another website
- ☐ Heard about it on TV or radio
- ☐ Read about it in a newspaper or magazine
- ☐ Heard about it at an event
- ☐ Somebody told me or shared it with me
- ☐ Other (please specify)

Consultation Questions

Question 1: Do you agree with our proposal that 'Phase 1' protections would be required to avoid the potential for significant disruption at ports and airports?

Question 2: Do you agree with the list of airports we propose to protect, in Annex A8?

Question 3: Do you have any comments on the two options we have proposed for the ports which would require protection, noting the further detail (and requests for specific evidence) in Annex A7?

Question 4: Do you agree with our preference to reduce these restrictions to 'Phase 2' levels over a shorter timeline than the natural lifecycle of the terminals?

Question 5: Taking into account the further detail in Annexes A7 and A8, please provide any evidence:

- that a shorter period, around five years, for the relevant receivers to be replaced or upgraded is not technically or practically feasible; or
- of the impact that a longer period of up to 20 years may have on the ability of MNOs to use the spectrum and the benefits to consumers and citizens that would be foregone.

Question 6: Do you agree with our proposal not to put in place restrictions on IMT use of this spectrum to protect: (a) land terminals; (b) potential future uses of the 1.5 GHz spectrum; or (c) PMSE users.

In this regard, we particularly welcome:

- any evidence that Inmarsat's land terminals are used for the operation of critical national infrastructure or safety purposes;
- any evidence that it is not technically or practically feasible to replace Inmarsat land terminals, including through alternative solutions or upgrades; and

- any evidence on the impact of protecting land terminals on the ability of mobile network operators ("**MNOs**") to use the spectrum and the benefits to consumers and citizens that may be foregone.

Question 7: Are you able to provide any evidence on the likelihood of audio links suffering interference from IMT use of 1492-1517 MHz?

Question 8: Do you agree with our proposed approach to coordination?

Question 9: Do you agree with our proposal to define PFD limited zones as complex polygons? Would defining them as a set of points, rather than an entire boundary, make coordination calculations easier for licensees?

Question 10: Do you agree with our provisional view that not defining coordination zones around ports may be simpler for licensees than complying with multiple different coordination zones, particularly while Phase 1 PFD limits are in place?

Question 11: Do you have any feedback on the coordination procedures (as set out in Annex A10) or the specific parameters proposed?

Question 12: How difficult would you find it to comply with our proposed coordination requirements? In particular, we are interested in information from potential licensees on how the proposed coordination zones would affect their deployment processes and decisions.

Question 13: Do you have any comments on our proposal that licensees should carry out their own coordination, on the basis of coordination parameters set by Ofcom?

Question 14: Do you have any comments on our proposed technical licence conditions?

Question 15: Do you have any comments on the non-technical licence conditions that we propose to include in the award licences?

Question 16: Do you have any comments on the proposed format for the auction?

Question 17: Do you have any comments on the proposed bidding options for the auction? Do you believe we have excluded any bidding options which would be worth identifying?

Question 18: Do you have any comments on our proposed information policy or reserve price?

Question 19: Do you have any other comments on the proposals or analysis set out in this consultation document?

A5. Legal framework

A5.1 This annex provides an overview of the main UK legislative provisions relevant to this consultation on the award of the 1497 – 1517 MHz band. It is not a full statement of all the legal provisions which may be relevant.

A5.2 Ofcom's statutory powers and duties in relation to spectrum management are set out primarily in the Communications Act 2003 (the "**CA 2003**") and the Wireless Telegraphy Act 2006 (the "**WTA 2006**").

Duties under the Communications Act 2003

A5.3 Section 3(1) of the CA 2003 states that it shall be our principal duty, in carrying out our functions:

a) to further the interests of citizens in relation to communication matters;[175]
b) to further the interests of consumers in relevant markets, where appropriate by promoting competition.[176]

A5.4 In doing so, we are required (among other things) to secure the optimal use of spectrum and the availability throughout the United Kingdom of a wide range of electronic communications services (section 3(2) of the CA 2003).

A5.5 In performing our duties, we are required under section 3(3) of the CA 2003 to have regard in all cases to the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed, and any other principles appearing to Ofcom to represent the best regulatory practice.

A5.6 Section 3(4) of the CA 2003 also requires Ofcom, in performing our duties, to have regard to a number of factors, where relevant, including:

a) the desirability of promoting competition (section 3(4)(b));
b) the desirability of encouraging investment and innovation (section 3(4)(d));
c) the desirability of encouraging availability and use of high speed data transfer services throughout the UK (section 3(4)(e));
d) the desirability of ensuring the security and availability of public electronic communications networks and services (section 3(4)(ea));
e) 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 (section 3(4)(f)); and

[175] "Citizens" means all members of the public in the United Kingdom (section 3(14) of the CA 2003).
[176] "Consumer" is defined in section 405(5) of the CA 2003 and includes people acting in their personal capacity or for the purposes of, or in connection with, a business.

f) 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 (section 3(4)(l)).

A5.7 In addition, section 3(5) of the CA 2003 requires that, when performing our duty to further the interests of consumers, we must have regard, in particular, to the interests of those consumers in respect of choice, price, quality of service and value for money.

A5.8 Where it appears to us that any of our general duties conflict with each other in a particular case, we must secure that the conflict is resolved in the manner we think is best in the circumstances (section 3(7) of the CA 2003).

A5.9 In carrying out our spectrum management functions, section 4(2) of the CA 2003 requires Ofcom to act in accordance with the following requirements:

a) to promote competition in communications markets;

b) to promote the interests of all members of the public in the United Kingdom;

c) to act in a manner which, so far as practicable, is technology neutral;[177]

d) to encourage, to the extent Ofcom considers it appropriate, the provision of network access and service interoperability for the purpose set out in section 4(8);[178]

e) to encourage compliance with certain international standards as is necessary for the purposes set out in section 4(9);[179] and

f) to promote connectivity and access to very high capacity networks by members of the public and businesses in the United Kingdom.

Duties under the Wireless Telegraphy Act 2006

A5.10 Additionally, in carrying out our radio spectrum functions we have a duty under section 3(1) of the WTA 2006 to have regard in particular to: (i) the extent to which the spectrum is available for use, or further use, for wireless telegraphy; (ii) the demand for use of that spectrum for wireless telegraphy; and (iii) the demand that is likely to arise in future for such use.

A5.11 We also have a duty under section 3(2) of the WTA 2006 to have regard to the desirability of promoting: (i) the efficient management and use of the spectrum for wireless telegraphy; (ii) the economic and other benefits that may arise from the use of wireless telegraphy; (iii) the

[177] According to section 4(6A) of the CA 2003, this requirement does not apply to the imposition, in relation to a wireless telegraphy licence, of a limitation of a kind falling within section 9ZA(1) of the WTA 2006; or (b) the review, variation or removal of such a limitation.

[178] The purpose of securing: (i) efficiency and sustainable competition, (ii) efficient investment and innovation, and (iii) the maximum benefit for the customers of communications providers and of persons who make associated facilities available.

[179] For facilitating service interoperability, end-to-end connectivity, the changing by end-users of their communications provider and the retention by end-users of their telephone numbers after a change of communications provider; and securing freedom of choice for the customers of communications providers.

development of innovative services; and (iv) competition in the provision of electronic communications services.

Ofcom's growth duty

A5.12 Under section 108 of the Deregulation Act 2015, Ofcom must have regard to the desirability of promoting economic growth when exercising spectrum management functions[180] – known as the 'growth duty'. This growth duty complements our general duties, including under section 3 of the Communications Act and the Wireless Telegraphy Act.

A5.13 In performing this duty, we will consider the importance of the promotion of economic growth and ensure any regulatory action we take is necessary and proportionate.

A5.14 Revised Growth Duty: Statutory Guidance has been published to assist Ofcom and other regulators in fulfilling their responsibilities under the growth duty. The guidance sets out how regulators such as Ofcom can better support sustainable economic growth through our decision-making and the way we regulate.

A5.15 Competition is identified within the statutory guidance[181] as one of the seven drivers of economic growth that regulators need to consider when complying with the growth duty. Ofcom's new growth duty will therefore complement our general duty under section 3 of the CA 2003 to have regard to the desirability of promoting competition in relevant markets.

UK Government's Statement of Strategic Priorities

A5.16 In line with our duty under section 2B(2) of the CA 2003, we must also have regard to the UK Government's designated Statement of Strategic Priorities (SSP) for telecommunications, management of radio spectrum and postal services.[182] The current designated SSP sets out the Government's key objectives in relation to spectrum,[183] which include:[184]

a) ensuring the efficient use of spectrum (including preventing under-utilisation of spectrum);

b) improving mobile coverage to meet current demands;

c) encouraging innovation and investment in new 5G services to meet future demands; and

d) promoting competition in mobile markets.

A5.17 As part of a commitment to providing the UK with world-class digital connectivity, the Government wants to expand high-quality geographic mobile coverage across the country

[180] See articles 1, 2(1) and the Schedule of The Economic Growth (Regulatory Functions) Order 2017 (S.I. 2017/267).
[181] Department for Business & Trade, 2024. Statutory Guidance under Section 110(1) of The Deregulation Act 2015; pages 10 and 15-16.
[182] DCMS, October 2019. Statement of Strategic Priorities for telecommunications, the management of radio spectrum, and postal services ("**Statement of Strategic Priorities**").
[183] If a new SSP is designated by the Secretary of State before we issue our final statement, we will have regard to it in reaching our final decisions.
[184] DCMS, Statement of Strategic Priorities, para. 35.

and become a world leader in the next generation of 5G mobile technology. In pursuit of this aim, the SSP identifies four strategic priorities to help create the conditions for a competitive mobile market that supports investment and innovation in 5G – one of which is to: "Promote new 5G services from existing and new players, through the release of additional spectrum".[185]

A5.18 The SSP also notes that mobile investment should be closely monitored by Ofcom and appropriate options considered if it becomes clear the current market structure is not supporting investment in 5G at sustainable levels.[186]

Harmonised technical conditions

The 1.4 GHz band

A5.19 When considering our relevant spectrum management duties, we must also take into account any Decisions adopted by the European Commission relating to the harmonisation of frequency bands[187] to the extent UK legislation still requires us to take such decisions into account.

A5.20 The Radio Spectrum (EU Exit) Regulations 2018 (EU Exit Regs) amend UK legislation to reflect how we should take into account certain EU Decisions after Brexit.

A5.21 Commission Implementing Decision 2018/661/EC (the **"2018 Decision"**) amended Commission Implementing Decision 2015/750/EC to refer to the harmonisation of the whole 1427 – 1517 MHz band including to make the 1497 – 1517 MHz band available for downlink-only mobile services.

A5.22 Ofcom must also designate and make available, on a non-exclusive basis, the 1.4 GHz frequency band for terrestrial systems capable of providing electronic communications services in compliance with the parameters set out in the Annex to Commission Decision 2015/750/EC.[188]

A5.23 For the avoidance of doubt, the above Commission Decisions are no longer directly part of UK law. However, Ofcom may consider it appropriate to authorise spectrum use of the relevant frequencies in line with the 2018 Decision on the basis of spectrum management reasons and/or to avoid causing any cross-border interference or harmonisation issues.

Ofcom's licensing framework

A5.24 Ofcom is responsible for managing the use of the radio spectrum. We do this by authorising the use of wireless telegraphy stations or apparatus either by:

[185] DCMS, Statement of Strategic Priorities, para. 33.
[186] DCMS, Statement of Strategic Priorities, para. 34.
[187] Commission Decisions are available here.
[188] See Reg. 6(2) of EU Exit Regs and Reg. 4(2) of the 1452-1492 MHz and 3400-3800 MHz Frequency Bands (Management) Regulations 2016/495.

a) granting wireless telegraphy licences under the WTA 2006 (also referred to as a spectrum licence); or

b) making regulations exempting the use of particular equipment from the requirement to hold such a licence.

A5.25 It is unlawful and an offence to install or use a wireless telegraphy station or apparatus without holding a licence granted by Ofcom, unless the use of such equipment is exempt.[189]

A5.26 The decisions set out in this document concern (among other things) our approach to the licence conditions to be included in any future licence authorising use of these bands for downlink-only mobile services. Below we explain the legal framework under which we can impose conditions in new spectrum licences.

Licence conditions

A5.27 A wireless telegraphy licence may be granted subject to such terms, provisions and limitations as Ofcom think fit (section 9(1) of the WTA 2006). However, this power is subject to certain constraints. In particular:

a) the terms, provisions and limitations of a spectrum licence must not duplicate the obligations already imposed on the licensee by the general conditions set by Ofcom under section 45 of the CA 2003 (section 9(6) of the WTA 2006);[190] and

b) Ofcom may only impose terms, provisions and limitations which are: a) objectively justified in relation to the network and services to which they relate; b) not unduly discriminatory; c) proportionate to what they are intended to achieve; and d) transparent in relation to what they are intended to achieve (section 9(7) of the WTA 2006).

A5.28 Section 9(4) of the WTA 2006 sets out a non-exhaustive list of the terms, provisions and limitations that Ofcom may impose.

A5.29 Examples of conditions that we may impose in spectrum licences under section 9 of the WTA 2006 include:

a) limitations as to the position and nature of a station (section 9(2)(a));

b) limitations as to the apparatus that may be installed or used (section 9(3)); and

c) terms, provisions and limitations as to strength or type of signal, as to times of use and as to the sharing of frequencies (section 9(4)(a)).

Licence awards

A5.30 Ofcom may allocate spectrum by way of an auction, having regard to the desirability of promoting the optimal use of spectrum (section 14 of the WTA 2006). The bidding process would be set out in auction regulations and in making such regulations, Ofcom must satisfy itself that the criteria for spectrum allocation are:

a) objectively justifiable in relation to the frequencies to which they relate;

[189] Section 8 of the WTA 2006.
[190] Ofcom, "General Conditions of Entitlement".

b) not such as to discriminate unduly against particular persons or against a particular description of persons;

c) proportionate to what they are intended to achieve; and

d) in relation to what they are intended to achieve, transparent (section 14(3B) of the WTA 2006).

A5.31 Auction regulations may make provisions with respect to the grant of the relevant licences and also the terms, provisions and limitations subject to which such licences are granted (sections 14(2) and 14(3)(h) of the WTA 2006). When designing competitive awards, Ofcom may impose a specified level of use requirement if doing so would promote the optimal use of spectrum (section 14(3C) of the WTA 2006).

Licence exemption for land mobile-satellite service stations

A5.32 Land mobile-satellite service stations (including those supplied by Inmarsat) are currently exempt from the requirement to hold a spectrum licence under the WTA, in accordance with Regulation 5(1) and Schedule 5 of The Wireless Telegraphy (Exemption) Regulations 2003 (SI 2003 No. 74).

A5.33 That exemption is subject to the terms, provisions and limitations set out in Schedule 5, which includes a requirement to comply with "IR 2016—UK Radio Interface Requirement for Land Mobile Satellites". This Interface Requirement imposes various technical requirements on the operation of a land mobile-satellite service station which the user must comply with in order to maintain the licence exempt status of the equipment.[191]

Impact Assessment

A5.34 Section 7 of the CA 2003 requires us to carry out and publish an assessment of the likely impact of implementing a proposal which would be likely to have a significant impact on businesses or the general public, or when there is a major change in Ofcom's activities.

A5.35 More generally, impact assessments form part of good policy making and we therefore expect to carry them out in relation to a large majority of our proposals. We use impact assessments to help us understand and assess the potential impact of our policy decisions before we make them. They also help us explain the policy decisions we have decided to take and why we consider those decisions best fulfil our applicable duties and objectives in the least intrusive way. Our impact assessment guidance sets out our general approach to how we assess and present the impact of our proposed decisions.

A5.36 The relevant duties in relation to the proposals on which we are consulting are set out in the Legal Framework section above. Our proposals are likely to impact on various stakeholders

[191] More generally, Regulation 3 of The Wireless Telegraphy Apparatus (Receivers) (Exemption) Regulations 1989 explains that receivers (i.e. equipment that is incapable of transmission) are generally licence exempt, presuming use of that equipment complies with those Regulations.

and where we have proposed alternative options, any impacts will depend on which option we choose. We have explained the potential impact of making the spectrum available for mobile operators, consumers and citizens, adjacent band users and Inmarsat throughout this document, in particular in Sections 3 and 4 and Annexes A7 and A8.

Ports and airports restrictions

A5.37 Any restrictions on mobile use of this spectrum would impact on mobile operators' ability to use the spectrum and the economic and consumer benefits that are likely to follow. Our proposals to impose Phase 1 restrictions around certain ports and airports is therefore likely to have an adverse impact on mobile operators and mobile consumers. However, our preference to protect a shorter list of ports and relax any restrictions over a shorter period, (around five years) would mitigate that adverse impact.

A5.38 Not imposing any restrictions has the potential to cause significant operational disruption to the maritime and aviation industries and our proposals to impose Phase 1 restrictions around certain ports and airports will help mitigate those potential impacts.

A5.39 Relaxing the protections will mean that the maritime and aviation industries, and potentially Inmarsat, will incur costs which they would not otherwise incur or incur those costs sooner than they otherwise would.

A5.40 To assess the magnitude of these impacts we consider the incremental costs of the protections being removed when compared with a counterfactual scenario of mobile not being made available in the 1.4 GHz band.[192] We first consider scenarios where the receivers would be replaced in the counterfactual and then consider scenarios where they would not.

A5.41 Some of the current receivers would be replaced with new receivers in the counterfactual.[193] In this scenario, the incremental cost of removing the protections would be zero or very low:

a) Some of the replacements or upgrades would be made within the Phase 1 period in the counterfactual, so there is virtually no incremental cost associated with the protections being removed.

b) Some of these replacements or upgrades would be made after the Phase 1 period in the counterfactual but would need to be brought forward to avoid interference when the protections are removed. In this case the incremental cost is the cost of bringing forward the purchase and installation of the new equipment.

A5.42 In both scenarios, the incremental cost is likely to be low.

A5.43 Some of the current receivers would not be replaced or upgraded in the counterfactual. In this case the incremental cost is related to upgrading or replacing the current receiver. These are costs which would be directly related to our decision to relax the protections.

[192] In terms of wider costs, we would expect the residual value of current receivers to be low given their relatively low initial value and the impact of depreciation over time.

[193] Some of these replacements may be motivated by the normal receiver-replacement lifecycles and/or to avoid blocking that may occur at non-UK ports and airports where the spectrum is made available for mobile with no, or limited, restrictions (and for receivers on aircraft, to comply with requirements under Project Iris).

A5.44 However, for aircraft, we understand that many of these receivers could simply be upgraded by, for example, installing additional filters without having to replace the existing system.[194] For those receivers that need to be replaced, both for maritime vessels and aircraft, we understand that equipment costs are relatively low.[195,196] The incremental effort required to replace these receivers would also be relatively low if they are replaced as part of a wider maintenance programme. They would also be low relative to the value of the aircraft or maritime vessel.

A5.45 The incremental costs we describe above may be lower if the Phase 1 restrictions are relaxed over a longer period. However, our provisional view is that the overall costs are likely to be relatively small, even with a shorter protection period, and are outweighed by the benefits to citizens and consumers from relaxing the protections sooner.

Land terminals protections

A5.46 Not imposing any restrictions specifically to protect land terminals (or other users of the adjacent band) could impose an incremental cost on some users (if they want to mitigate the risk of blocking). Our current view is that the risk of these costs arising is low as it requires various dependencies to all crystallise (paragraphs 4.23-4.32). Even if the costs do arise, our current view is that those costs are objectively justifiable compared to the benefits that would be lost by the restrictions we would otherwise have to place on IMT deployments to avoid those costs. Specifically, we understand that the cost of land terminals is relatively low[197] and are likely to represent a small proportion of the overall cost of the user's operations; and any terminals that need to be replaced are likely to have been in service for some time and, therefore, partially or fully depreciated.

Overall assessment

A5.47 As explained in Section 3, our proposals involve striking an appropriate balance between (i) allowing the users of adjacent bands, in particular in the maritime and aviation industries, sufficient time to upgrade (where necessary), and (ii) ensuring the efficient use of the spectrum (i.e. reducing restrictions on IMT use as soon as practical). We provisionally consider our proposals and preferred options strike an appropriate balance that allows us to achieve our objectives.

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[194] Paragraph 3.79

[195] We understand a new ship earth station cost around £5,000, plus installation costs (see, for example, Sailor 6100 and Felcom 18) and [CONFIDENTIAL ✂]). For reference, second hand cargo ships appear to cost between US$1.7 million-24 million and a second hand commercial fishing vessel (which may not use a ship earth station) appears to cost between £90,000 and £1.5 million. (Find a Fishing Boat, Commercial Fishing Boats - Over 15m)

[196] We understand from [CONFIDENTIAL ✂] it equates to between approximately [CONFIDENTIAL ✂] per aircraft for a full refit. We would expect that the cost of only installing a filter would be significantly lower. For reference, new commercial aircraft cost between US$90 million to over US$300 million (Axon aviation group, aircraft pricing) while the hourly operating costs of these aircraft range from US$5,000-10,000 (EUROCONTROL, Aircraft operating costs).

[197] We understand satellite phone handsets costs range from £300-1500 (Satphone), and BGAN terminals range from £3,000-£13,000 (GTC).

A5.48 Overall, and for the reasons explained more fully in Sections 3 and 4 and Annexes A7 and A8, we provisionally consider that the benefits of making the spectrum available for IMT outweigh any potential adverse impacts on adjacent band users, and consider our proposals to be proportionate.

Equality Impact Assessment

A5.49 Section 149 of the Equality Act 2010 (the "**Equality Act**") imposes a duty on Ofcom, when carrying out its functions, to have due regard to the need to eliminate discrimination, harassment, victimisation and other prohibited conduct related to the following protected characteristics: age; disability; gender reassignment; marriage and civil partnership; pregnancy and maternity; race; religion or belief; sex and sexual orientation. We refer to groups of people with these protected characteristics as 'equality groups'.

A5.50 The Equality Act also requires Ofcom to have due regard to the need to advance equality of opportunity and foster good relations between persons who share specified protected characteristics and persons who do not.

A5.51 Section 75 of the Northern Ireland Act 1998 (the **"NI Act"**) also imposes a duty on Ofcom, when carrying out its functions relating to Northern Ireland, to have due regard to the need to promote equality of opportunity and have regard to the desirability of promoting good relations across a range of categories outlined in the NI Act. Ofcom's Revised Northern Ireland Equality Scheme explains how we comply with our statutory duties under the NI Act.

A5.52 To help us comply with our duties under the NI Act and the Equality Act, we assess the impact of our proposals on persons sharing protected characteristics and in particular whether they may discriminate against such persons or impact on equality of opportunity or good relations.

A5.53 When thinking about equality we think more broadly than persons that share protected characteristics identified in equalities legislation and think about potential impacts on various groups of persons (see paragraph 4.7 of our impact assessment guidance).

A5.54 In particular, section 3(4) of the CA 2003 also requires us to have regard to the needs and interests of specific groups of persons when performing our duties, as appear to us to be relevant in the circumstances. These include:

a) the needs of persons with disabilities, older persons and persons on low incomes; and

b) the different interests of persons in the different parts of the UK, of the different ethnic communities within the UK and of persons living in rural and in urban areas.

A5.55 We consider that our proposals would have an over-arching positive impact on all consumers and citizens, given that one of our objectives is to secure the optimal use of spectrum for the benefit of society as a whole. Our proposal to make the upper 1.4 GHz band available for mobile may have particularly positive benefits for groups of people living in areas that may be more likely to benefit from the additional coverage that the upper 1.4 GHz spectrum can provide (e.g. rural areas).

A5.56 As explained in Section 3, we propose to impose restrictions on mobile network operators ("**MNOs**") using this spectrum around some ports and international commercial airports. Groups of people living in those areas may not benefit from this additional spectrum in the

same way as people living in similar areas that are not subject to restrictions. We have taken into account these potential impacts on groups of people living in areas subject to restrictions when provisionally deciding which ports and international commercial airports it would be proportionate to protect as well as considering an appropriate timeframe for relaxing these restrictions on MNOs.

A5.57 It is also possible that our proposals may have an adverse impact on some equality groups to the extent they may be more likely to utilise affected Inmarsat equipment on ships and aircraft in the adjacent band. As explained in Section 3, we have taken these potential impacts on users of Inmarsat equipment into account when provisionally deciding that it would be proportionate to protect some ports and international commercial airports. As explained in that section, we also intend to take various steps to help mitigate the impact on users of the adjacent band including:

a) Proposing an appropriate timeframe for users to upgrade or replace affected equipment before we move to more relaxed protections.

b) Liaising with the MCA and CAA and making relevant stakeholders aware of this consultation, so that we can take account of their views.

A5.58 We welcome comments on the potential impact of our proposals on specific groups of people and our proposals to mitigate any adverse impacts.

Welsh language assessment

A5.59 The Welsh Language (Wales) Measure 2011 made the Welsh language an officially recognised language in Wales. This legislation also led to the establishment of the office of the Welsh Language Commissioner who regulates and monitors our work. Ofcom is required to take Welsh language considerations into account when formulating, reviewing or revising policies which are relevant to Wales (including proposals which are not targeted at Wales specifically but are of interest across the UK).

A5.60 Where the Welsh Language Standards are engaged, we consider the potential impact of a policy proposal on (i) opportunities for persons to use the Welsh language; and (ii) treating the Welsh language no less favourably than the English language. We also consider how a proposal could be formulated so as to have, or increase, a positive impact, or not to have adverse effects or to decrease any adverse effects.

A5.61 Our proposals to make the 1497 – 1517 MHz band available for mobile relate to a nationwide licensing scheme and should improve broadband delivery for consumers across the UK. We do not consider our proposals will have any impact on our Welsh language obligations.

A6. Detailed summary of responses regarding protection of adjacent band satellite receivers on maritime vessels and aircraft

Mobile network operators supported more limited protective requirements

A6.1 The mobile network operators ("**MNOs**") and the Global System for Mobile Communications Association ("**GSMA**") acknowledged the need for protective requirements around ports and airports but encouraged Ofcom to balance protections with maximising the availability of the spectrum in the 1492-1517 MHz block.[198]

A6.2 VMO2 noted that the proposed coordination zones would be extensive and in highly populated areas, which would mean that mobile deployment was "significantly restricted". However, based on Ofcom's analysis, the size of the zones was "to be expected".[199]

A6.3 Vodafone argued that our coexistence analysis could be "tempered with practical deployment characteristics, which in some cases may be specific to UK deployments", implying that this would be more accurate and demonstrate that more limited protective requirements would be sufficient.[200]

A6.4 Vodafone also noted that alternative means of communication (such as mobile) are often available, which it stated "should influence Ofcom's thinking where regulatory judgement calls need to be made."[201] BT/EE recognised that it is "important to ensure that there is very low risk of interference to mobile satellite terminals where there are no alternative networks available or where the impact of interference would be high even if the risk were low".[202]

A6.5 H3G requested that we limit coordination measures to specific ports and airports where our analysis suggests blocking is likely, in order to minimise any adverse impact on MNO's deployments and maximise spectrum efficiency. It said we should conduct more detailed

[198] VMO2, CFI response, p. 2, Q. 4; BT/EE, CFI response, p. 5, Q. 5; H3G, CFI response, p. 9; Vodafone, CFI response, p. 2, Q. 1; GSMA, CFI response, p. 1-2.
[199] VMO2, CFI response, p.1, Q. 2.
[200] Vodafone, CFI response, p. 2, Q. 1.
[201] Vodafone explained that "whilst MSS is of critical importance at sea, in the port/port approach areas … MSS is one of a series of communications mechanisms, for example in the Thames estuary and Solent areas ships would likely have terrestrial mobile communications with which to summon help". Vodafone, CFI response, p. 2, Q. 1.
[202] BT/EE, CFI response, p. 5, Q. 5.

analysis for each port and airport to propose more targeted measures.[203] Vodafone also considered it was important to assess the volume of best and worst performing Inmarsat devices in UK waters and where they are used to assess which areas may actually need protecting in practice.[204]

A6.6 Both BT/EE and the GSMA noted that the Danish regulator, SFDI, had decided not to impose restrictions on mobile use around ports and had only imposed restrictions around airports which have regular transatlantic flights.[205] In light of this, the GSMA questioned the proportionality of the approach proposed in the October 2023 call for input ("**CFI**") on the basis that "interference has no direct impact on flight and ship safety", and argued that Ofcom should adopt a similar approach to the SDFI.[206]

The MCA and Viasat supported more extensive protective requirements

A6.7 Viasat said that "all MSS terminals operating throughout the 1518-1559 MHz should be protected".[207] Viasat outlined the importance of its satellite network in broad terms, stating that it is "relied upon as an emergency backup, capable of continuing to provide timely, critical, and often life-saving communications when terrestrial networks are unavailable."[208] [CONFIDENTIAL ✂].[209] It also recommended that, in order to protect current MSS operations, "Ofcom should postpone use of the band, or … [limit] use to indoor base stations".[210]

A6.8 John Shaw said that our proposed protections did not go far enough, arguing that "the measures proposed would not prevent considerable damage to the viability of mobile satellite communication services for land, sea and aeronautical applications in the adjacent frequency bands above 1518 MHz".[211]

Maritime

A6.9 The Maritime and Coastguard Agency ("**MCA"**) stated that the zones set out in the CFI failed "to protect the remaining areas around the coast where vessels currently have

[203] H3G, CFI response, p. 9.
[204] Vodafone, CFI response, p. 3, Q. 4.
[205] BT/EE, CFI response, p.4, Q. 1.
[206] GSMA, CFI response, p. 1.
[207] Viasat CFI response, p. 8, Q.2.
[208] Viasat, 2 April 2025 response to Ofcom's March 2024 statutory information request ("**Information request - April response**"), cover letter, p. 2; Viasat, Response to Ofcom regarding confidentiality of 22 January 2025 ("**Confidentiality response**"), p. 7, Table 1.
[209] Viasat, Information request - April response, cover letter, p. 2; Viasat, Confidentiality response, p. 50-52, Table 2.
[210] Viasat, CFI response, p. 10, Q. 4.
[211] Shaw, J, CFI response, p. 2, Q. 1.

uninterrupted MSS, nor the land-based use of MSS for maritime purposes". It considered that greater restrictions should be adopted.[212]

A6.10 Viasat and John Shaw expanded on this. John Shaw noted that "there are many more areas around the coast, and on the approaches to ports via river estuaries and waterways… where communications must be maintained". Viasat argued that it the approach in the CFI was "underinclusive" for disregarding "terminals that operate close to shore [and] on waterways". Both highlighted that the approach failed to consider the impact on autonomous ships (also known as unmanned surface vehicles ("**UAVs**") or Maritime Autonomous Surface Ships ("**MASS**"))." [213]

A6.11 While Viasat concluded that the identified ports looked "reasonably complete",[214] the MCA noted that neither Ofcom nor ECC Report 299 provided a clear definition of ports and that the provision of ports changes over time depending on where they are needed.[215]

A6.12 The MCA also raised concerns about the impact of potential mobile coverage over the sea on ships, should protection requirements not be implemented effectively, noting that the "signal strengths from current UK or French IMT base stations appear sufficient to maintain connectivity cross the entire Dover/Calais sea route."[216]

A6.13 Viasat advised that interference to maritime terminals from mobile use in the "1.4 GHz band would likely affect more than eighty thousand UK Mariners, exclusive of foreign flagged vessels."[217]

A6.14 [CONFIDENTIAL ✂] and the MCA also highlighted a number of other uses of MSS in the maritime sector which required protection:

a) The MCA noted that there are a number of international maritime obligations, including Long Range Identification and Tracking ("**LRIT**") and Ship Security Alerting System ("**SSAS**"). It noted that these systems "commonly rely upon [recognised MSS] because of the high service availability", and that "areas where [recognised MSS] is blocked create opportunities for bad actors.[218] In addition, the MCA noted "a variety of operational tasks including reporting, compliance with ILO convention (crew welfare), engine management".[219]

b) [CONFIDENTIAL ✂] highlighted that "Interference from the operations contemplated by Ofcom would likely disrupt safety communications that are required under international and UK law. Inmarsat-C terminals are able to support these mandatory communication requirements, including Long Range Identification and Tracking ("**LRIT**"); Common European Reporting System ("**CERS**"); Maritime safety information ("**MSI**"); International Ship and Port Facility Security ("**ISPS**") Codes; Search and Rescue ("**SAR**"); and Inshore

[212] MCA, Confidential CFI response, p. 4, Q 2; MCA, Response to Ofcom regarding confidentiality of 20 December 2024 ("**Confidentiality response**"), p. 1.
[213] Shaw J, CFI response, p. 4-5, Q. 2; Viasat, CFI response, p. 6, Q. 1.
[214] Viasat, CFI response, p. 9, Q. 2.
[215] MCA, Confidential CFI response, p. 5, Q. 2; MCA, Confidentiality response, p. 1.
[216] MCA, Confidential CFI response, p. 5, Q. 2; MCA, Confidentiality response, p. 1.
[217] Viasat, Confidential CFI response, p. 13, Q.7; Viasat, Confidentiality response, p. 53, Table 2.
[218] MCA, Confidential CFI response, p. 6, Q. 2; MCA, Confidentiality response, p. 3.
[219] MCA, Confidential CFI response, p. 12, Q. 7; MCA, Confidentiality response, p. 3.

Vessel Monitoring Systems ("**I-VMS**") on fishing vessels. Many of these applications must be fully operational, even while in port (stationary) or on approach (e.g., LRIT). Moreover, GMDSS communications are required to be tested before departure."[220]

A6.15 Stakeholders also commented on the impact that insufficient protections would have on long term maritime strategy and competition:

a) John Shaw stated that "impending developments such as autonomous ships make it essential that the whole coastline should be protected", a move that would also support satellite only maritime communications. He also noted that "control and monitoring of autonomous ships would need at least two independent means of robust satellite communications".[221]

b) The MCA noted that marine autonomous surface ships ("**MASS**") are part of the UK's Maritime 2050 strategy and require "the highest availability and bandwidths… for remote control or where live video images may be required"[222] and highlighted that [CONFIDENTIAL ✂][223]

c) The MCA noted that [CONFIDENTIAL ✂].[224]

d) The MCA stated that that "ports are significant economic operators and need to be able to develop where they are needed to maximise economic and sustainability benefits" and that "uncertainty about the ability of vessels to use satellite services because of IMT licences would work as an inhibitor to future developments". Additionally, it highlighted that "Maritime 2050, the Government's long term strategy document for the maritime sector suggests an increased need for port facilities in the future".[225]

e) The MCA and John Shaw highlighted that the "lack of spectrum for L-band MSS services has been a long-standing problem" which had led to the extension of the band (1518-1525 MHz) at WRC-03. The MCA argued that "loss of spectrum above 1518 MHz on account of terminal blocking and significant spurious and out-of-band emissions would therefore compromise the viability of 1.5/1.6 GHz MSS services in and to the detriment of user demand and commercial imperatives" and that this would lead to reduced competition.[226,227]

Aviation

A6.16 [CONFIDENTIAL ✂] noted that Inmarsat Satcom terminals are used to provide "compulsory safety communications" and that interference could compromise the provision of the aeronautical mobile satellite (route) service ("**AMS(R)S**") and Future Air Navigation System

[220] [CONFIDENTIAL ✂]
[221] Shaw J, CFI response, pp. 4-5, Q. 2.
[222] MCA, Confidential CFI response, p. 12, Q. 7; MCA, Confidentiality response, p. 1.
[223] MCA, Confidential CFI response, p. 5, Q. 2.
[224] MCA, Confidential CFI response, p. 5, Q. 2, MCA, Confidentiality response, pp. 1-2.
[225] MCA, Confidential CFI response, p. 5, Q. 2; MCA, Confidentiality response, pp. 2-3.
[226] MCA, CFI response, p. 5, Q. 2; Shaw J, CFI response, p. 3, Q. 1 and p. 6, Q. 4.
[227] We note that this reduced access would be a result of vulnerable receivers, which we expect will be upgraded, as opposed to reduced spectrum access. We do not consider that competition based on the quality of products to be unfair competition.

("**FANS 1/A**").[228] [CONFIDENTIAL ✂][229] It also highlighted that "Satcom are used over continental airspace to avoid switching from Satcom to VHF, which alleviates congestion on heavily used VHF channels".[230] It noted that, [CONFIDENTIAL ✂].[231]

A6.17 Viasat said that "Commercial disruption will occur if flight routes between North America and Europe are unable to make use of the North Atlantic Oceanic Track System ("NAT-OTS"), which requires the use of L-Band FANS 1/A satellite communications systems to communicate with air traffic control."[232] It argued that "if satcom were not operational on the ground for a large number of, or even all, UK aircraft trying to cross the Atlantic, the impact would be so significant that Air Traffic Service Providers may need to modify regulations and/or airspace design, and airlines may need to modify operating procedures."[233]

A6.18 Viasat highlighted that "L-band terminals are also used on unmanned aircraft and Ofcom has recently introduced a regulatory framework to enable L-band MSS terminals on unmanned aerial vehicles ("**UAV**") to be licensed for UK operations"[234] It added that our analysis failed to give equal consideration to all of its services and [CONFIDENTIAL ✂].[235]

A6.19 John Shaw stated that "there are many more UK aerodromes licensed under CAA regulations than considered in the analysis".[236]

Timescales for upgrading equipment

A6.20 Again, the MNOs and the GSMA generally supported a shorter timeframe for moving to reduced restrictions, while Viasat and the MCA stressed the need for longer time periods.

A6.21 Vodafone considered that "Ofcom has an important leadership role to take on the topic: if Ofcom were to publicise that poorer performing devices were no longer afforded protection from a given fate, then this would send a powerful message to the users of such equipment to replace them or face safety consequences". However, it advised that it was not in a position to propose a date, but that the timing should be sooner rather than later.[237]

A6.22 BT/EE considered five years as a suitable period to move to relaxed protections, noting that "a period of 5-7 years was discussed in the ECC Report 299 published 4 years ago" and so the industry had been aware of the need for upgrades for some time"[238] The GSMA agreed that a five-year transition period to the new mobile earth satellite stations would be appropriate

[228] [CONFIDENTIAL ✂]
[229] [CONFIDENTIAL ✂]
[230] [CONFIDENTIAL ✂]
[231] [CONFIDENTIAL ✂]
[232] Viasat, Information request - April response, cover letter, p. 2; Viasat, Confidentiality response, p. 62, Table 2.
[233] Viasat, Information request - April response, cover letter, p. 2; Viasat, Confidentiality response, p. 55.
[234] Viasat, CFI response, p. 1, Q. 1.
[235] Viasat, Confidential CFI response, p. 2, Q. 1.
[236] Shaw J, CFI response, p. 4.
[237] Vodafone, CFI response, p.3, Q. 5.
[238] BT/EE, CFI response, p. 5, Q. 5.

for airports "due to the impact of the area of the coordination zones around airports on prospective mobile deployments".[239]

A6.23 VMO2 noted that the main issue "relates to older satellite receivers with poor selectivity" and suggested that "a timeline for replacing those receivers should be signalled, after which the risk of interference moves to the satellite receiver user". It also the recommendation in ECC Report 299, but considered that this was "rather optimistic", noting the lengthy life cycles of equipment on ships and aircraft.[240]

A6.24 Viasat disagreed with the 5-7 year PFD limit relaxation timescale that had been proposed in ECC Report 299. It noted that this timeframe related to the notice period for the closure of legacy MSS services, as opposed to the replacement of equipment. It quoted both the International Maritime Organization ("**IMO**") which had warned that "that the example timescale of 7 years is too short to be achievable, given the process required", and the International Civil Aviation Authority ("**ICAO**"), which argued that any timescales for transition should "reflect the natural replacement cycle of aeronautical equipment, typically 25 years or more".[241]

A6.25 The MCA also felt that 5-7 years was "too short if it is to be aligned with the availability and expected take-up of equipment with improved blocking performance" and suggested that a period of 15-20 years would be more realistic, noting that it understood that "some currently installed Inmarsat-C SES are being maintained in excess of 15 years".[242] It also noted that the IMO's new "performance standards for Inmarsat-C GMDSS ship installations with improved blocking performance" applies from 1 January 2028, having been delayed from 1 January 2024 when it became clear that "it was unlikely that equipment compliant with the … standards could be made available and placed on the market by 1 January 2024". The MCA expects products with the enhanced standard to be available before 1 January 2028.[243] The MCA highlighted that replacement of current MSS terminals would be "inconvenient, lengthy and costly" and "raises issues of whether forced replacement of internationally harmonized equipment at some time as a requirement to trade to ports in UK would constitute a non-tariff barrier to trade."[244]

A6.26 John Shaw said: "present generation of MSS terminals conforms to internationally mandated and harmonised performance standards for terminals fitted on ships and aircraft – standards that were perfectly adequate when the carriage requirements were mandated. Several international and regional organizations, including IMO, ICAO, IMSO and EUROCONTROL, have advised that the proposed replacement programme would be a lengthy, inconvenient, and costly exercise."[245] He also noted that the "IMO advised CEPT in 2018 and 2020 that

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[239] GSMA, CFI response, p. 3, Q. 5.
[240] VMO2, CFI response, pp. 2-3, Q. 4-5.
[241] Viasat, CFI response, pp. 10-11, Q. 5; IMO, Liaison Statement to CEPT ECC, Document ECC(20)INFO 02; ICAO, ICAO Liaison Statement to ITU-R Working Parties 4C and 5D (2018)
[242] MCA, CFI response, pp. 6 and 8, Q.5.
[243] MCA, CFI response, p. 7, Q. 5; MCA, Guidance, MIN 700 (M+F) Radio communications – delay to IMO performance standards, paras. 1.2.3 and 1.3; IMO, Resolution MSC.513(105); IMO, MSC.1/Circ.1676 - Delays affecting the availability of new GMDSS equipment compliant with the revised performance standards set out in resolutions MSC.511(105), MSC.512(105) and MSC.513(105)
[244] MCA, Confidential CFI response, p. 4, Q. 2; MCA, Confidentiality confirmation, p. 2.
[245] Shaw J, CFI response, p. 4, Q. 2.

timescales envisaged for relaxing the PFD limits [i.e. 7 years] were not realistic in respect of Inmarsat GMDSS terminals fitted on board ships" and would require a special regulatory measure to be enforced.[246]

Suggestions for further analysis

A6.27 Viasat noted that Ofcom's analysis, which was based on ECC Report 299, had only reported on the highest performing aero receiver. It advised that Ofcom should conduct analysis with Viasat to "ensure that all possible interference scenarios …[and] all deployed MES are considered".[247]

A6.28 Vodafone considered that our analysis should go further and "gain evidence from Inmarsat as to the volume of [MSS terminals] typically in UK waters/airspaces, and potentially evidence as to the level of usage". It explained that such analysis would help to establish the resilience levels of terminals typically in UK waters, enabling Ofcom to apply appropriate levels of protection, including on a "per port/airport basis".[248]

[246] Shaw J, CFI response, p. 8, Q. 5.
[247] Viasat, CFI response, p. 9, Q. 1.
[248] Vodafone, CFI response, p. 3, Q. 4.

A7. Further detail on our maritime proposals

Background

A7.1 In Section 3, we refer to:

a) our understanding of the legal and operational framework applicable to use of Satcom on maritime vessels;

b) the various options we have considered for which ports are likely to require protection in order to avoid the potential for significant disruption; and

c) how we have provisionally determined when it might be appropriate to relax the PFD limits which we are proposing to impose around certain ports.

A7.2 In this Annex, we provide further detail on the factors we have taken into account in reaching our proposals relating to the use of Satcom on maritime vessels.

Legal and operational framework for use of Satcom on ships

A7.3 Below we summarise our understanding of the legal and operational requirements that apply to MSS equipment on maritime vessels.[249] This summary is intended to provide a high-level overview of requirements to use or test Inmarsat terminals and summarise where Inmarsat terminals may be used to meet legal or operational requirements. While we provide examples of different requirements and uses, they are non-exhaustive and this Annex is not intended to identify every possible requirement or use of Inmarsat terminals.

A7.4 This Annex takes into account discussions we have had with the Maritime and Coastguard Agency ("**MCA**"), the UK's maritime regulator,[250] as well as ECC Report 299 and responses to the CFI.

Summary

A7.5 We understand that Inmarsat C MSS terminals are used on ships to meet safety requirements, as well as for more general communications and other services. In this context, Inmarsat C terminals are referred to as Inmarsat Ship Earth Stations ("**SES**"). These terminals also incorporate an Enhanced Group Call ("**EGC**") service.

A7.6 Internationally, there is a general legal requirement on some maritime vessels engaged on international voyages (including passenger and cargo ships of a certain size) under the Safety

[249] We refer to maritime vessels and ships interchangeably throughout this consultation.
[250] The MCA has not carried out a detailed review of this Annex or approved its contents.

of Life at Sea Convention ("**SOLAS**") to have a ship earth station terminal installed if they are sailing further out to sea.

A7.7 These ship earth station terminals must receive their satellite service from an approved Global Maritime Distress and Safety System ("**GMDSS**") service, i.e. Inmarsat or Iridium. However, Iridium was only formally authorised to provide satellite GMDSS services in 2020 and is being rolled out via a phased implementation process – meaning that its terminals do not yet provide coverage globally. Many ships subject to SOLAS will therefore have installed an Inmarsat C terminal to meet relevant safety requirements.[251]

A7.8 The legal requirements that apply to ships not subject to SOLAS depend on various factors including the type of vessel and relevant national rules of the flag state.

A7.9 Under UK rules, we understand Inmarsat ship earth station terminals are primarily required, or may be relied on, to comply with relevant safety requirements on larger fishing vessels, high speed craft on international voyages and large commercial yachts used for sport and pleasure that travel further out to sea.

A7.10 Where ships rely on Inmarsat C terminals to meet safety requirements, they may be subject to a legal and/or operational requirement to check they are working, and in some circumstances, they may be required to carry out this check before they leave port. In some circumstances, a failure of Inmarsat C equipment at port may mean that the ship cannot leave port or is restricted to travelling closer to shore.

A7.11 For a significant number of vessels, there is no safety requirement or recommendation to install a ship earth station as they do not travel far enough out to sea – although some ships may have still chosen to install one for safety or non-safety purposes.

International context

A7.12 Internationally, the main requirements relating to MSS equipment are set out in SOLAS.[252] However, SOLAS only applies to certain ships that are engaged on international voyages, including passenger ships carrying more than 12 passengers and larger cargo ships; it does not generally apply to certain types of vessels including cargo ships of less than 500 gross tonnage, fishing vessels or pleasure yachts.[253]

A7.13 Different flag states have their own safety requirements for vessels which are not caught by SOLAS. We have summarised some of the UK rules below. Other flag states impose their own safety requirements on vessels registered to them, which apply to those vessels when they are in UK ports and waters. We understand that these national rules largely align with

[251] We understand Inmarsat also provides FleetBroadband MSS terminals although these are not a GMDSS requirement. Only Inmarsat C terminals are a Ship Earth Station, and this legal and operational framework focuses on requirements relating to Inmarsat C terminals.

[252] International Convention for the Safety of Life at Sea (SOLAS), 1974 (although note that some chapters, including Chapter IV, have been separately updated via Resolutions). See also the different chapters of SOLAS that are referenced in this Annex.

[253] Each chapter includes more specific detail on the type of ships it applies to (see Chapter I, Regulations 1 and 3).

SOLAS[254] and have summarised examples of UK rules applying to different types of vessels below.

A7.14 There are other non-safety related obligations imposed on different types of vessel at the international and national level.[255] While these obligations may not require the use of MSS (or Inmarsat MSS), ships may choose to rely on MSS to meet those obligations.

The Safety of Life at Sea Convention ("SOLAS")

A7.15 SOLAS is an international maritime treaty which sets out the minimum safety standards in the construction, equipment and operation of merchant ships. The International Maritime Organisation ("**IMO**") is responsible for SOLAS and requires signatory flag states to ensure that ships flagged by them meet these requirements. A number of certificates are prescribed in SOLAS as proof that this has been done.[256]

Global Maritime Distress and Safety System ("GMDSS")

A7.16 SOLAS identifies various requirements relating to the GMDSS. The GMDSS is a communications system designed to ensure safety at sea and is used for:

a) emergency and distress messages; and
b) vessel-to-vessel, and vessel-to-shore, routine communications.[257]

A7.17 Specifically, SOLAS Chapter IV explains that ships must be capable of a number of functional requirements relating to GMDSS communications,[258] including:

a) transmitting ship-to-shore distress alerts by at least two separate and independent means, each using a different radiocommunication service in any area in which the vessel will be sailing; and
b) receiving Maritime Safety Information ("**MSI**") which includes warnings about weather and other hazards.

A7.18 These GMDSS requirements apply to a broader set of ships that are engaged on international voyages, including passenger ships carrying more than 12 passengers and cargo ships of at least 300 gross tonnage.[259] Other vessels may comply with GMDSS requirements on a voluntary basis or under a national regulation.

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[254] [CONFIDENTIAL ✂]
[255] Examples include requirements under the International Labour Organisation Convention and requirements relating to fishing vessel monitoring systems. Also see paragraph A7.32 below.
[256] SOLAS, Chapter I, Part B.
[257] See https://www.gov.uk/maritime-safety-weather-and-navigation/the-global-maritime-distress-and-safety-system
[258] SOLAS, Chapter IV, Regulation 4 (as set out in Resolution MSC.496(105)).
[259] SOLAS, Chapter I, Regulations 1 and 2(f) and Chapter IV, Regulation 1 (as set out in Resolution MSC.496(105)).

Maritime Safety Information ("MSI")

A7.19 SOLAS requires ships to be provided with a receiver or receivers capable of receiving MSI and search and rescue related information throughout the entire voyage in which the ship is engaged.[260]

A7.20 MSI is broadcast every twelve hours on recognised Mobile Satellite Services ("**MSS**").[261] In the UK, the relevant broadcast times are 0530-0600 and 1730-1800.[262] While MSI is also broadcast on NAVTEX (Navigational telex), it only covers the service areas covered by NAVTEX (out to 270 miles).[263] Ships travelling outside of NAVTEX service areas (including in Sea Area A3) therefore need access to the MSI broadcast on MSS[264] while at port to plan a safe route to their destination.

Equipment requirements

A7.21 To ensure that ships are capable of meeting the above requirements, SOLAS Chapter IV sets out requirements for mandatory GMDSS equipment on relevant ships.[265]

A7.22 The GMDSS equipment required by ships depends on the sea area in which the ship intends to sail.[266] Ships intending to sail closer to the coast (referred to as Sea areas A1 and A2), are not required to use satellite services for GMDSS communications, but it is one of multiple options available to them. Ships intending to sail in Sea area A3 are required to use MSS.[267]

A7.23 Historically, Inmarsat was the only MSS provider recognised by the IMO for ships to meet SOLAS requirements. Since January 2020, Iridium has also been recognised by the IMO as an MSS provider for the purposes of the GMDSS.[268] Iridium services do not use the 1518-1559 MHz band, and so will not be impacted by mobile use in the 1.4 GHz band.

A7.24 However, many ships may have installed an Inmarsat C terminal prior to 2020 and MSI coverage on Iridium's network is still not yet available worldwide, as it is being rolled out in phases.[269] This means that Inmarsat C terminals may have remained the only viable option

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[260] SOLAS, Chapter IV, Regulation 7 (as set out in Resolution MSC.496(105)).
[261] Only Inmarsat and Iridium are currently recognised providers of MSS. Also see section on "Equipment requirements" below.
[262] MCA, Guidance, Navigational warnings.
[263] UK Government, Maritime safety: weather and navigation
[264] While UK MSI is made available by the UK Hydrographic Office on its website, legally the only trusted source is the official broadcast. The UKHO advises that it "is not intended to be a substitute for, or an alternative to, the International Enhanced Group Call (EGC) Services or the International NAVTEX service, and does not relieve Masters/Captains of their responsibility to monitor MSI broadcasts in accordance with the provisions of SOLAS."
[265] SOLAS, Chapter IV, Part C (as set out in Resolution MSC.496(105)).
[266] SOLAS, Chapter IV, Part C (as set out in Resolution MSC.496(105)).
[267] SOLAS, Chapter IV, Regulations 8 - 11 and the definition of the various "Sea Areas" in Regulation 2 (as set out in Resolution MSC.496(105)). The Merchant Shipping (Radiocommunications) (Amendment) Regulations 2021 give effect in UK law to the requirements of SOLAS Chapter IV, as amended (see Regs. 4 and 7 and MCA Statutory guidance MSN 1903 (M) GMDSS ship requirements).
[268] Iridium, Press Release dated 13 January 2020.
[269] Iridium, SafetyCast Implementation Status; Iridium, GMDSS Service Updates.

for some ships after 2020. We understand Iridium's MSI coverage has improved significantly from 2020, but that some areas still receive partial, or no, coverage.[270]

Testing requirements

A7.25 SOLAS requires ships to conduct surveys to check that GMDSS equipment is working.[271] These surveys must be conducted in port at least annually, but can be required more frequently.

A7.26 The IMO provides guidance for conducting surveys and advises that Inmarsat SES can be inspected by "checking for correct operation by inspection of recent hard copy or by test call".[272] We understand a recent MSI broadcast can be used as evidence, which can either be printed out as a hard copy or made visible on the ship's MSS equipment screen.[273]

A7.27 If it cannot be demonstrated that a ship's GMDSS equipment works, the ship may be considered unseaworthy which may result in it being detained or restricted to a particular voyage.[274]

A7.28 To comply with SOLAS requirements, we understand equipment is also expected to be checked following any routine maintenance or repairs.[275]

A7.29 More generally, we understand ships may be subject to inspections by port state control[276] or the relevant flag state. The type and frequency of these inspections depends on the type of vessel, but they may include checking any MSS equipment works.

A7.30 While it may not be necessary to *test* Inmarsat MSS in port (or *test* it every time before a ship leaves port), we recognise that in certain circumstances testing of MSS equipment in port may be the only means to pass an inspection or comply with another requirement. Testing of MSS equipment in port may also be part of a ship's routine operational procedures.

Uses of MSS to meet other legal or operational requirements

A7.31 While there may be no legal requirement to use Inmarsat's MSS for non-safety communications, we understand it is also used for general communications (such as in areas where VHF and MF connections may be less reliable or more limited in capacity), as well as for more specific services including:[277]

a) commercial email which:

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[270] Iridium, press release dated 11 December 2024.
[271] SOLAS Chapter I, Regulations 7 and 9. See also IMO Circular, COMSAR.1/Circ.32/Rev.2, section 1.10.
[272] See, for example, IMO Resolution A.1104(29), sections 4.1.2.12, 4.2.2.1 and 4.3.2.1; and ECC Report 299, section 3.2.3.
[273] Meeting notes from [CONFIDENTIAL ✂].
[274] Chapter IV, Regulation 15.8 (as set out in Resolution MSC.496(105)); ECC Report 299, section 3.2.3; and [CONFIDENTIAL ✂].
[275] See SOLAS, Chapter IV, Regulation 15 (as set out in Resolution MSC.496(105)) and IMO Circular, COMSAR.1/Circ.32/Rev.2, section 1.6.
[276] See IMO on Port State Control and MCA Guidance on Port State Control Expanded Inspections.
[277] See ECC Report 299, Annex 1 and [CONFIDENTIAL ✂].

i) can be used for general coordination and communication of commercial maritime operations;

ii) is used by ships to meet legal requirements, such as emailing upcoming ports with relevant information to meet their Consolidated European Reporting System Workbook and International Ship and Port Security Codes requirements;

b) Long Range Identification and Tracking ("**LRIT**"), which is primarily a security system;

c) Ship security alerting system ("**SSAS**"), a covert system for reporting to a competent authority that the vessel security has been compromised;

d) internet access for passengers;

e) general radiocommunications access for crew to meet International Labour Organisation Convention (crew welfare) requirements;

f) fishing vessel monitoring systems; and

g) engine monitoring by shore services to optimise operation and control emissions.

A7.32 Some ships may be subject to legal or operational requirements relating to some of these other uses of Inmarsat's MSS equipment which may, for example, require equipment to be used or tested at or before leaving port.

UK Rules

A7.33 In the UK, requirements are set out in merchant shipping regulations[278] and codes of practice applicable to different types of vessel that are issued by the MCA.

A7.34 Some of these Codes require (or recommend) certain vessels to install MSS or Inmarsat MSS when travelling further out to sea. We have summarised examples of the rules applying to different types of vessels below:

a) Rules requiring installation of MSS or Inmarsat MSS, including as an alternative to other equipment,[279] which are applicable to vessels including:

i) Medium fishing vessels between 15 – 24 metres in length (if new) or between 15 - 45 metres in length (if existing) where Inmarsat C is required in Sea Area A3 (and an alternative option in Sea Area A2) and Inmarsat EGC is required in Sea Areas A3 and A4.[280]

[278] These include The Merchant Shipping (Radiocommunications) (Amendment) Regulations 2021, and The Merchant Shipping (Radio) (Fishing Vessels) Regulations 1999, as amended ("Fishing Regs").

[279] Including (i) Inmarsat ship earth station as an alternative to MF/HF radio with DSC or a satellite service in the 406 MHz band; (ii) or Inmarsat EGC as an alternative to NAVTEX.

[280] Fishing Regs, Part III - Reg. 21 and Schedule 4 identify the requirements relating to radio equipment. See also Section 9.2 of The Code of Safe Working Practice for the Construction and Use of Fishing Vessels of 15m Length Overall to less than 24m Registered Length (MSN 1872 Amndt 1 (F)).

ii) Larger fishing vessels of at least 24 metres in length (if new) or at least 45 metres in length (if existing) where Inmarsat MSS is an alternative option in Sea Areas A1-A3[281] (and required in Sea Area A1 where NAVTEX is not available).[282]

iii) High speed craft on international voyages where Inmarsat MSS is identified as an alternative option in Sea Areas A1-A3[283] (and required in Sea Area A1 where NAVTEX is not available).[284]

iv) Large commercial yachts used for sports or pleasure which are up to 24 metres in length, do not carry cargo or more than 12 passengers where:

- For existing vessels, Inmarsat is generally identified as an alternative option for ships travelling more than 60 nautical miles[285] from a safe haven (unless travelling in areas where NAVTEX is not available or north of 70 degrees North or south of 70 degrees South, in which case Inmarsat is required).[286]
- For new vessels and vessels subject to major conversion, Inmarsat is identified as an alternative option in Sea Area A3 (and required if travelling in sea areas where NAVTEX is not available).[287]

v) Cargo ships of not less than 300 gross tonnage on domestic voyages and certain passenger ships made from glass reinforced plastics or wood where MSS is an alternative option in Sea Areas A1 – A3[288] (and required in Sea Area A1 where NAVTEX is not available).[289]

b) Rules recommending the installation of MSS or Inmarsat MSS as an alternative option to MF/high frequency ("HF") radio with DSC for ships travelling further out to sea which are applicable to vessels including:

i) Small workboats and pilot boats that are at least 60 nautical miles from a safe haven.[290]

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[281] Fishing Regs, Part II, Regs. 11 – 14. See also Section 9.2 of The Code of Practice for the Construction and Safe Operation of Fishing Vessels of 24m Registered Length and Over (MSN 1873 Amndt 1 (F)).
[282] Fishing Regs, Regs. 10(e).
[283] The Merchant Shipping (High Speed Craft) Regulations 2022, Regulation 9 and the International Code of Safety for High Speed Craft ("High Speed Craft Code"), Sections 14.8 – 14.11.
[284] High Speed Craft Code, section 14.7
[285] A nautical mile is 1,852 metres.
[286] See The Large Commercial Yacht Code ("LY3"), Section 16.3.1, including Table 1 and Notes 1 and 2.
[287] LY3, Section 16.3.3, including Table 2 and Note 1.
[288] The Merchant Shipping (Radio Installations) Regulations 1998 and MCA Statutory guidance MSN 1903 (M) GMDSS ship requirements, paragraphs 3 – 7.
[289] MCA Statutory guidance MSN 1903 (M) GMDSS ship requirements, paragraph 3.1.5.
[290] See Code of practice for the safety of small workboats and pilot boats (Brown Code), Table 1 on page 65 and Section 3.2 which identifies Inmarsat as an example of suitable satellite equipment that could be installed as an alternative.

ii) Large existing commercial yachts used for sports or pleasure which are up to 24 metres in length, do not carry cargo or more than 12 passengers and which travel in Sea Area A2 and beyond.[291]

c) Rules not identified above which do not require or recommend the installation of MSS which are applicable to vessels including:

i) Small commercial motor vessels of up to 24 metres in length which do not carry cargo or more than 12 passengers.[292] These vessels should not travel further than 15 nautical miles from the point of departure or 3 nautical miles from land.[293]

ii) Small commercial sailing vessels of up to 24 metres in length which do not carry cargo or more than 12 passengers.[294] These vessels should not travel further than 15 nautical miles from the point of departure or 3 nautical miles from land.[295]

iii) Small commercial vessels used for sport or pleasure which are up to 24 metres in length, do not carry cargo or more than 12 passengers and which operate from a nominated departure point.[296] These vessels should not travel further than 3 miles from land or 20 miles from the nominated departure point.[297]

iv) Small seagoing passenger ships of less than 24 metres in length, carrying no more than 250 passengers and operating within 15 miles of a place of refuge and no more than 5 miles from the coast.[298]

Summary of UK requirements to use MSS

A7.35 For ships outside of SOLAS, we understand Inmarsat C terminals are primarily required, or may be relied on, to comply with relevant safety requirements on larger fishing vessels, high speed craft on international voyages and large commercial yachts used for sport and pleasure that travel further out to sea.

A7.36 We recognise that where Inmarsat C terminals are installed, ships may be subject to a legal and/or operational requirement to check it is working, and in some circumstances, they may be required to carry out this check before they leave port.[299] In some cases, a failure of

[291] See LY3, section 16.3, Table 1, note 3 which states: "For existing vessels it is strongly recommended that MF/HF DSC or INMARSAT option is fitted to cover the sea area outside of A1."
[292] See Code of practice for the safety of small commercial motor vessels (Yellow Code). Section 16.1.3 of the Code states that: "Having regard to the range limitations of VHF, radio equipment should be provided which has a range capability commensurate with that need for the intended area of operation."
[293] See section 1.4 of the Yellow Code.
[294] See Code of practice for the safety of small commercial sailing vessels (Blue Code). Section 16.1.3 states: "Having regard to the range limitations of VHF, radio equipment should be provided which has a range capability commensurate with that needed for the intended area of operation."
[295] See section 1.4 of the Blue Code.
[296] See Code of practice for the safety of small vessels in commercial use for sport or pleasure operating from a nominated departure point (Red Code). Section 16 only refers to a VHF requirement.
[297] See section 1.4 of the Red Code.
[298] See Small Seagoing Passenger Ships Code, Section 1.1 and 14.2.
[299] See, for example, sections 11 and 17 of Annex 2 of LY3.

Inmarsat C may result in a ship being considered unseaworthy and delays at port.[300] In other cases:

A7.37 Requirements to ensure the availability of MSS equipment do not require that equipment to be tested or used in port. Rather, the availability of equipment is to be ensured using such methods as duplication of equipment, shore-based maintenance or at-sea electronic maintenance capability, or a combination of these.[301]

A7.38 Various checks are often required to be carried out at sea rather than in port and those checks may not in any event require MSS equipment to be checked.[302]

A7.39 For a significant number of vessels, there is no safety requirement or recommendation to install MSS as they do not travel far enough out to sea. As a general rule, we are not aware of any safety requirement for a vessel to have MSS or Inmarsat MSS installed if it does not travel in Sea Area A3 (and NAVTEX is available). While Inmarsat MSS may be an alternative option in sea areas closer to shore, we understand there are various other options available and consider that ships that do not travel in Sea Area A3, are less likely to have installed Inmarsat MSS.

A7.40 We recognise that ships may have installed Inmarsat MSS for other non-safety purposes. We are not however aware of any specific evidence that (i) vessels have installed, and rely on, Inmarsat MSS for these other purposes; (ii) these vessels are required to test or use this equipment while in or around ports where there is no alternative means of communication available; and (iii) if Inmarsat MSS does not work in port, there are likely to be delays to a vessel leaving port or other operational difficulties. For example, we have not seen any evidence that ships using UK ports generally use Inmarsat MSS for fishing monitoring purposes[303] or that there is any requirement for this equipment to be switched on in UK ports.[304] More generally, we understand that most systems that may rely on Inmarsat MSS to meet legal and/or operational requirements are either used primarily at sea, or that there are other ways to meet them when at port, such as IMT.

Which ports is it appropriate to protect?

A7.41 In Section 3, we set out our provisional view that it would be appropriate to impose Phase 1 restrictions on mobile use at ports. We also set out the options we had considered for which

[300] Presuming that failure means the vessel is incapable of performing all distress and safety functions. See, for example, section 14.15.9 of The High Speed Craft Code.
[301] See, for example, sections 14.15.5 and 14.15.6 of The High Speed Craft Code; and section 16.9.1 of LY3. See also Reg. 18 of The Merchant Shipping (Radio Installations) Regulations 1998; Reg. 17 of the Fishing Regs and Section 9.2 of MSN 1872 Amndt 1 (F); and Reg. 26 of the Fishing Regs and Section 9.2 of MSN 1873 Amndt 1 (F) which do not identify any requirement for MSS terminals to be tested in port.
[302] See, for example, Reg. 17(9) and Schedule 2 to the Fishing Regs.
[303] See, for example, Marine Management Organisation, List of I-VMS type approved devices for under 12 metre English vessels which identifies SC2 as an approved I-VMS tracking device and we understand this device connects to the Iridium network.
[304] See, for example, Marine Management Organisation, Vessel monitoring system devices, Device requirements - Statutory guidance on Inshore Vessel Monitoring (I-VMS) for under-12 metre fishing vessels registered in England.

ports we should impose restrictions around. In particular, we identified the following two alternative options for the type of ports we could protect:

a) all 51 major ports in the DfT's dataset; or

b) all 160 major and minor ports in the DfT's dataset.

A7.42 We also set out our provisional view that it would not be appropriate to protect a longer list of ports, future ports, or the entire UK coastline (see paragraphs 3.54-3.58).

Initial assessment of which ports we should protect

Option 1 – all major ports

A7.43 Our understanding, as set out above, is that a ship earth station, such as Inmarsat C, is generally only required on maritime vessels that travel into Sea Area A3. While Inmarsat C may be an alternative option for meeting safety requirements in sea areas closer to shore, we understand there are various other options available and consider that maritime vessels that do not travel in Sea Area A3,[305] are less likely to have installed an Inmarsat C terminal.

A7.44 It is possible that the minor ports in the Department for Transport's ("**DfT**") dataset are primarily used by vessels that do not travel in Sea Area A3 or have not otherwise installed an Inmarsat C terminal.

A7.45 We also recognise that vessels more likely to use minor ports may have installed Inmarsat MSS equipment for other non-safety purposes, such as inshore vessel monitoring systems ("**I-VMS**") on fishing vessels under 12 metres. As explained in paragraph A7.41, we have not however seen any evidence that ships using these minor ports generally use Inmarsat MSS for fishing monitoring purposes or that there is any requirement for this equipment to be switched on in UK ports. Even where vessels using minor ports in the DfT's dataset have installed Inmarsat MSS terminals, it is therefore possible that any potential impact may be limited.

A7.46 For these reasons, we invite comments on this option to only protect the major ports in the DfT's dataset, in particular any evidence that:

a) maritime vessels using the minor ports in the DfT's dataset have installed, and rely on, Inmarsat MSS;

b) these vessels are required to test or use this equipment while in or around these minor ports where there is no alternative means of communication available; and

c) if Inmarsat MSS does not work in port, there are likely to be delays to a vessel leaving port or other operational difficulties.

A7.47 Comments based on hypothetical or potential scenarios are less helpful and less reliable than comments based on actual evidence or objective facts, particularly in the context of justifying more significant restrictions on IMT.

[305] Viasat provided the following global breakdown of the types of vessel which use Inmarsat C: [CONFIDENTIAL ✂].

Option 2 – all major and minor ports

A7.48 While maritime vessels using the minor ports on the DfT's list may not travel as far out to sea and may be less likely to rely on Inmarsat MSS terminals, we recognise that these vessels may nonetheless rely on Inmarsat MSS terminals and there may be reasons why they must use their MSS in or around port.

A7.49 It may therefore be appropriate to protect all major and minor ports in the DfT's dataset and we welcome evidence on this option, in particular the impact that protecting the longer list of all major and minor ports may have on the ability of mobile network operators ("**MNOs**") to use the spectrum and the economic and consumer benefits that are likely to follow.

Longer list of up to approximately 1,700 ports

A7.50 We have also considered whether we should protect an unofficial longer list of up to around 1,700 ports (provided to us by the MCA).

A7.51 Our provisional view is that all of the ports in this longer list are unlikely to require protection and we consider that many of them are likely to be used by vessels that do not travel in Sea Area A3 or have not otherwise installed an Inmarsat C terminal.

A7.52 We also consider that many of the ports in this longer list would already be protected by protecting the ports identified in the DfT's list of all major or all major and minor ports (Options 1 and 2 above). In particular, the longer list of around 1,700 ports includes multiple entries for ports within the area covered by a single port on the DfT's list. For example, there are at least nine ports in the list of around 1,700 ports that are likely to fall within the area covered by Southampton port on the DfT's list.

A7.53 We further provisionally consider protecting up to around 1,700 ports to be similar to protecting the entire UK coastline, which is likely to significantly impact the ability of MNOs to use the spectrum and the economic and consumer benefits that are likely to follow. We explain below why we have provisionally concluded that it would not be appropriate to protect the entire coastline (which would include all UK ports, however they may be identified).

A7.54 For these reasons, our provisional view is that restrictions on IMT use of this spectrum around up to approximately 1,700 ports would not enable us to achieve our objectives and consider the DfT's list to provide a more reliable basis on which to identify ports that may require protection. Notwithstanding this, we welcome any evidence that:

a) maritime vessels using ports that are not covered by any of the major or minor ports in the DfT's dataset have installed, and rely on, Inmarsat MSS;

b) these vessels are required to test or use this equipment while in or around these ports where there is no alternative means of communication available; and

c) if Inmarsat MSS does not work in port, there are likely to be delays to a vessel leaving port or other operational difficulties.

Future ports

A7.55 We have considered whether we should provide protection for future port developments from IMT use as and when they are established. While we acknowledge concerns that future developments may be inhibited by a lack of protection, we consider it important that the award licences provide licensees with certainty about the locations in which they are

permitted to deploy, and it would not be practical to require them to reconfigure their planned and deployed networks.

Coastal areas

A7.56 We have also considered whether we should protect the whole of the UK coastline (which may also include protecting some more inland areas such as the mouth of a river). In particular, we are aware of concerns around the impact of blocking in areas with particularly high maritime traffic, such as the English Channel, and areas which are subject to more turbulent weather conditions, like the Scottish islands.

A7.57 We recognise that some maritime vessels may rely on a combination of VHF and Inmarsat MSS for safety requirements when they are closer to shore and that in some circumstances:

a) VHF may not work (for example, due to weather and sea conditions); and

b) Inmarsat MSS receivers may not work (due to the MNOs using the 1492-1517 MHz band in these more remote areas and then interfering with any use of Inmarsat MSS).

A7.58 In our view, this may be a hypothetical scenario which is unlikely to materialise in practice. We note that Government Guidance on GMDSS VHF DSC procedures shows a map of the UK indicating VHF is available all around the UK coastline and refers to Sea Area A1 as: "The radiotelephone coverage of VHF coast stations in which continuous alerting by DSC is available".[306]

A7.59 In the unlikely event that this scenario does occur, our proposals to protect certain ports are likely to cover certain coastal areas where shipping lanes come close to the coast, such as our proposed PFD limited zone for Southampton, Portsmouth and the Solent (see Figures 5.3 and 5.4 of Section 5). There are also various alternative options to relying on Inmarsat C in coastal areas, including but not limited to use of MF and/or a mobile phone with a SIM card from each of the MNOs.[307] It would also be open to ship owners that consider this issue to be a real risk to upgrade their Inmarsat C terminals to a more resilient model.

A7.60 We further provisionally consider protecting the entire UK coastline is likely to significantly impact the ability of MNOs to use the spectrum and the economic and consumer benefits that are likely to follow. As a result, our provisional view is that restrictions on IMT use of this spectrum along the whole of the UK coastline would not enable us to achieve our objectives, but welcome evidence on:

a) the practical limitations of VHF in coastal areas;

b) the number of vessels that rely on a combination of VHF and Inmarsat C for safety requirements when they are closer to shore; and

c) why switching to an alternative means of communication or upgrading Inmarsat equipment is not technically or practically feasible.

[306] See Government Guidance on GMDSS VHF DSC procedures for small boat users under section "Global Maritime Distress and Safety System (GMDSS) sea areas"

[307] See, for example, Regulations 10 and 11 of The Merchant Shipping (Radio) (Fishing Vessels) Regulations 1999.

Proposed ports for protection

A7.61 Below are the lists of major and minor ports, as identified by the Department for Transport.[308]

Major ports

Figure A7.1: Major ports[309]

Major ports for potential protection		
Aberdeen	Great Yarmouth	Orkney
Belfast	Grimsby & Immingham	Peterhead
Boston	Harwich	Plymouth
Bristol	Heysham	Poole
Cairnryan	Holyhead	Port Talbot
Cardiff	Hull	Portsmouth
Clyde	Ipswich	Ramsgate
Cromarty Firth	Larne	River Trent
Dover	Liverpool	Rivers Hull and Humber
Dundee	Loch Ryan	Shoreham
Felixstowe	London	Southampton
Fishguard	Londonderry	Sullom Voe
Fleetwood	Manchester	Sunderland
Forth	Medway	Swansea
Fowey	Milford Haven	Tees & Hartlepool
Glensanda	Newhaven	Tyne
Goole	Newport	Warrenpoint

Minor ports

Figure A7.2: Minor ports

Minor ports for potential protection		
Anglesey Marine Terminal	Garston	Perth

[308] Department for Transport, Port and domestic waterborne freight statistics, PORT0101: all freight tonnage traffic by port and year.

[309] We have removed Kilroot power station jetty from the list, on the understanding that Kilroot power station closed in September 2023; we also removed Stranraer harbour, which we understand closed in 2011.

Appledore	Gill's Bay Scotland	Port Askaig
Ardrishaig	Girvan	Port Penrhyn
Ayr	Gweek	Porthoustock
Bangor	Hughtown (St Mary's)	Portrush
Barnstaple	Inverkeithing	Preston
Barra Castlebay	Inverness	Red Bay
Barrow	Irvine	River Ouse
Barry	Killyleagh	Rye
Berwick-On-Tweed	Kilroot	Sandwich
Bideford	King's Lynn	Scalloway
Blyth	Kirkcudbright	Scrabster
Bridgwater	Kyle of Lochalsh	Seaham
Bridport	Lancaster	Sharpness
Brightlingsea	Larne Bank Quays	Shotton
Buckie	Lerwick	Silloth
Burghead	Littlehampton	Stornoway
Burry Port	Llandulas	Sutton Bridge
Caernarfon	Llanelli	Tayport
Carrickfergus	Loch Carnan	Teignmouth
Charlestown	Lochaline	Torquay
Chichester	Lossiemouth	Troon
Colchester	Lowestoft	Truro
Coleraine	Macduff	Ullapool
Corpach	Magheramorne	Wallasea
Cowes, Isle of Wight	Maldon	Warkworth
Craignure	Mistley	Watchet
Dartmouth	Montrose	Wells
Dean Point Quarry	Mostyn	Weymouth & Portland
Dutch River Wharf	Neath	Whitby & Scarborough
Exmouth	Newlyn	Whitehaven
Falmouth	Newport, Isle of Wight	Whitstable
Fareham	Padstow	Wick
Folkestone	Par	Wisbech
Fosdyke	Penarth	Workington

Fraserburgh	Penryn	
Garlieston	Penzance	

When would it be appropriate to move to 'Phase 2' PFD limits?

A7.62 As set out in Section 3, paragraphs 3.91-3.100, we have considered two high level options for reducing the PFD limits from the Phase 1 to the Phase 2 levels:

a) **Option A**: An accelerated upgrade process over a relatively short Phase 1 period, around five years from the date of our final decision. In order to avoid the risk of blocking once restrictions are relaxed to Phase 2 levels, we would expect maritime vessel operators to upgrade the Inmarsat receivers most at risk within the specified period; or

b) **Option B**: A natural retirement and upgrade process, taking up to 20 years to transition from Phase 1 to Phase 2 restrictions, starting from the date of our final decision. In order to avoid the risk of blocking, we would expect maritime vessel operators to upgrade the Inmarsat receivers most at risk from blocking within the specified period, most likely at the point that the affected terminal would naturally be retired.

Option A – approximately five years

A7.63 This option takes into account a range of factors including:

a) We understand that upgrading a terminal on a maritime vessel is likely to be relatively straightforward and could be conducted during a routine maintenance, which we expect to be carried out at least annually (and note that ships subject to SOLAS are subject to a survey at least annually, as set out in paragraph A7.26).

b) Our assessment of the impact of a relatively short protection period is that the costs would be low and would be outweighed by the benefits (see paragraph A5.37-A5.45). More generally, we understand that the cost of an upgrade is low relative to the overall cost of the vessel.[310]

c) We consider it reasonable to assume it would take approximately one year for Inmarsat and/or equipment manufacturers to carry out the necessary testing and/or for affected vessel owners to become aware of the need to upgrade and then a further 1-2 years for those vessel owners to arrange for their equipment to be upgraded. That still leaves an additional two years in case it takes longer for vessel owners to become aware and/or arrange an upgrade (for example, because there are a limited number of engineers available to upgrade the affected equipment). It is also of course open to Inmarsat and equipment manufacturers to start carrying out testing as soon as possible and not to wait until we issue our statement at the end of this consultation process.

[310] Second hand cargo ships appear to cost between US$1.7 million-24 million (NautiSNP, Container ships for sale) and a second hand commercial fishing vessel (which may not use a ship earth station) appears to cost between £90,000 and £1.5 million (Find a Fishing Boat, Commercial Fishing Boats - Over 15m) We understand a new ship earth station costs around £5,000 (e.g. Sailor 6100 and Felcom 18), plus installation costs ([CONFIDENTIAL ✂]).

d) We note that all vessels were required to implement Electronic Chart Display and Information Systems within a much shorter timeframe of three years[311] – which indicates it is possible to communicate the need to make changes, and make those changes, within a short period of time.

e) As explained in paragraph 3.75 above, we are currently only aware that roughly half [CONFIDENTIAL ✂] (approx. [CONFIDENTIAL ✂]) of Viasat's Inmarsat C maritime receivers for which we have resilience data[312] would be likely to suffer from harmful blocking from IMT without Phase 1 protections and therefore need to be upgraded. We also understand that roughly half of the receivers which we have resilience data for are already resilient to blocking at or around Phase 2 protection levels.[313] Therefore, a significant number of Inmarsat terminals in relation to which we have not been able to obtain resilience data may in fact be resilient to Phase 2.[314]

f) In addition, the Inmarsat receivers which we understand are likely to be resilient to Phase 2 were [CONFIDENTIAL ✂]. As a result, our understanding is that some terminals that have been available for over 10 years are unlikely to require upgrading, again indicating the number of terminals which require upgrading may be significantly lower than our worst case scenario (see below) might suggest.

g) In any event, in a worst-case scenario (i.e. where *all* Inmarsat maritime receivers currently in circulation need to be upgraded), approximately 125,000-130,000 [CONFIDENTIAL ✂] receivers would need to be upgraded. Assuming that (i) it would take approximately one year for Inmarsat and/or equipment manufacturers to carry out the necessary testing and/or for affected vessel owners to become aware of the need to upgrade, and (ii) upgrades can take place for 50 weeks of each year, this would equate to at most 650 [CONFIDENTIAL ✂] receivers requiring an upgrade per week of the 4-year period, meaning approximately 13 [CONFIDENTIAL ✂] receivers would need to be upgraded per week for each port on the DfT list of all major ports or approximately 4 [CONFIDENTIAL ✂] receivers per week for each port on the DfT list of all major and minor ports. We do not consider these figures to be unrealistic and in any event:

    i) These figures are likely to be lower as we understand some receivers in circulation are likely to already be resilient at Phase 2, and many of the receivers for which we do not hold resilience data may in fact already be resilient at Phase 2.[315]

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[311] The International Maritime Organization issued resolution MSC.530(106)/REV.1 in November 2022, establishing updated performance standards for Electronic Chart Display and Information Systems (ECDIS).

[312] As explained in Section 3, Viasat holds data on the resilience of around 25% of all Inmarsat C terminals in circulation.

[313] This means that at least [CONFIDENTIAL ✂]% (and potentially many more) of the Inmarsat C terminals currently in circulation are resilient to blocking at or around Phase 2 protection levels.

[314] We also note from Table 6 of ECC Report 299 that the Inmarsat C models most susceptible to interference without Phase 1 restrictions (Models 1 and 2 in Table 6) stopped being produced in 2005. On the basis that receivers are likely to be upgraded every 20-30 years (see section 4.3 of ECC Report 299), we would expect that many of these Inmarsat C models most susceptible to interference have now been upgraded to a newer, more resilient model. We do, however, recognise that Inmarsat may have provided ships with newer models that were also susceptible to interference without Phase 1 restrictions.

[315] The confidential figures above reflect our understanding of how many terminals are already likely to be resilient to Phase 2 and are unlikely to need upgrading.

ii) The number of vessel owners that will need to arrange an upgrade will be lower as we know that some vessels have installed more than one Inmarsat receiver.[316]
iii) Upgrades would not be restricted to UK ports and the resources required to upgrade equipment could be spread across ports worldwide. This should mitigate any potential resourcing or availability issues within the UK.
iv) Many receivers may have already been, or would be, upgraded in any event as they would have reached their end of life.[317]

h) We also note that the IMO adopted a resolution on 28 April 2022 recommending that Governments ensure that every Inmarsat-C SES which forms part of the GMDSS, and which is installed on or after 1 January 2024, conforms to updated performance standards which would require equipment to be resilient at Phase 2 protections.[318] While that date has subsequently been extended to 1 January 2028,[319] this IMO resolution demonstrates the international move to more resilient equipment and some Inmarsat C terminals are already likely to have been upgraded in line with those updated performance standards. We consider this IMO resolution is also likely to encourage manufacturers to accelerate production of more resilient equipment (and in advance of 2028). Indeed, the MCA has also explained that it expects more resilient equipment to be available before 1 January 2028.[320]
i) Following extensive consultation, the ECC Report suggested a period of 5-7 years for moving to Phase 2[321] and at the time of consulting, no other country that has imposed restrictions around ports has suggested any longer timeframe.[322]
j) In our view, it is not realistic or fair to the maritime industry to suggest affected vessel owners are likely to ignore the requirement to upgrade in the absence of any legally binding mandate, particularly if Inmarsat and/or the MCA help ensure that owners are made aware of the need to upgrade and the potential consequences of failing to do so.
k) The significant adverse impact of a longer transition period on achieving optimal use of spectrum, efficient use of the upper 1.4 GHz band for IMT and the ongoing economic and consumer benefits that is likely to bring (particularly if we decide it is appropriate to protect DfT's longer list of all major and minor ports). We consider it would be inefficient to allow investment and improvements in the quality in mobile phone

[316] Some maritime radiocommunication safety requirements can be met by the duplication of equipment, such as Inmarsat C terminals. For example, see the High Speed Craft Code, paragraph 14.15.6.
[317] ECC Report, section 4.3.
[318] Resolution MSC.513(105), clause 3.
[319] MSC.1/Circ.1676, clause 5. See also MCA Guidance MIN 700 (M+F) Radio communications – delay to IMO performance standards. Further information on standards and type approvals applicable to MSS terminals are set out in MCA Notice MSN 1874 (M+F) Amendment 9 Marine Equipment – United Kingdom conformity assessment procedures for marine equipment, Other Approval and Standards.
[320] MCA, CFI response, p. 7, Q. 5; MCA, Guidance, MIN 700 (M+F) Radio communications – delay to IMO performance standards, paras. 1.2.3 and 1.3; IMO, Resolution MSC.513(105); IMO, MSC.1/Circ.1676 - Delays affecting the availability of new GMDSS equipment compliant with the revised performance standards set out in resolutions MSC.511(105), MSC.512(105) and MSC.513(105)
[321] ECC Report 299, section 4.5.
[322] For example, Denmark, which auctioned the spectrum in 2021, only protected international airports and set a deadline of 1 January 2025 for the move to Phase 2 (SDFI, HØRINGSNOTAT, p. 17). Austria auctioned the spectrum in 2020 and set a deadline of 1 January 2028 for the move to Phase 2 (RTR, Anlage zum Bescheid F 1/16-394 der Telekom-Control-Kommission vom 19.10.2020, p.7).

services used by millions of consumers to be held back by outdated technology in some MSS terminals while up to date, more resilient alternatives are available.

Option B – up to 20 years

A7.64 This option takes account of the possibility that a longer period of up to 20 years may be appropriate if maritime vessel owners are not made aware of the need to upgrade their receiver(s) (for example, by Inmarsat) or otherwise decide not to take any action in the absence of a legal mandate.

A7.65 In this scenario, affected receivers would only be upgraded when existing receivers reach the end of their life. We have suggested up to 20 years taking into account responses to the CFI and subsequent discussions with stakeholders, in particular the MCA. We also note that ECC Report 299 explains that "the useful economic life of a commercial vessel is approximately 20-30 years, where vessels are scrapped from service with most of the initial equipment they were delivered with".[323]

A7.66 We have not identified any other reasons to favour a longer period of up to 20 years but welcome evidence on why a longer period may be necessary. Under this option, mobile network operators would need to constrain their deployment of the spectrum for a period of 20 years, delaying the benefits to mobile consumers for approximately 15 years compared to Option A.

[323] ECC Report 299, section 4.3.

A8. Further detail on our aviation proposals

Background

A8.1 In Section 3, we refer to:

a) our understanding of the legal and operational framework applicable to use of Satcom on aircraft; and

b) how we have provisionally determined when it might be appropriate to relax the PFD limits which we are proposing to impose around international commercial airports.

A8.2 In this Annex, we provide further detail on the factors we have taken into account in reaching our proposal for when it might be appropriate to relax the PFD limits around international commercial airports.

Legal and operational framework for use of Satcom on aircraft

A8.3 The sub-section below summarises our understanding of the legal and operational requirements that apply to MSS equipment on aircraft. It is intended to provide a high-level overview of requirements to use or test Inmarsat terminals, and summarise where Inmarsat terminals may be used to meet legal or operational requirements. While we provide examples of different requirements and uses, they are non-exhaustive and this Annex is not intended to identify every possible requirement or use of Inmarsat terminals.

A8.4 This Annex takes into account discussions we have held with the Civil Aviation Authority ("**CAA**"), the UK's aviation regulator, as well as ECC Report 299 and responses to the CFI.

Summary

A8.5 We understand Inmarsat's MSS terminals are used to provide an aeronautical mobile satellite (route) service (AMS(R)S). In particular, they are used to implement controller–pilot data link communications ("**CPDLC**") which is a method by which air traffic controllers can communicate with pilots over a datalink system. CPDLC is a text-based product commonly known as a satellite communication system ("**Satcom**") or data link. Viasat has said that its Inmarsat Satcom terminals are "operated on the ground, at low altitudes, and cruising altitudes" and used to provide "flight-critical, real-time safety information about flight progress, weather and engine performance".[324]

A8.6 There is no general legal requirement on aircraft to use Inmarsat's Satcom, or which requires Satcom to be tested prior to take-off.

[324] Viasat, CFI response, p. 1 Q. 1.

A8.7 However, airline operators may choose to rely on Inmarsat's Satcom to meet legal requirements. The legal requirements that apply depend on various factors including the type of aircraft and relevant national rules.

A8.8 We understand it is also best practice and/or an operational requirement for aircraft to test their Inmarsat Satcom before taking off. For example, the Future Air Navigation System ("**FANS**") effectively imposes an operational requirement on flights departing for the North Atlantic region to check that their Satcom equipment is working prior to departure in order to make use of certain aircraft tracks and altitudes.

International context

A8.9 The International Civil Aviation Organization ("**ICAO**") issues guidance, standards and recommended practices to facilitate cooperation between countries and improve safety performance at the international level. ICAO has also played a key role in FANS (which is discussed further below). While the ICAO's initiatives may not be legally binding, they are considered best practice and can be incorporated into the operational requirements of airline operators.

A8.10 The CAA regulates aviation in the UK and has issued various rules and regulations.

A8.11 We have summarised the key UK rules and ICAO initiatives applicable to Inmarsat's MSS equipment below.

UK rules

UK Air Navigation Order

A8.12 The UK Air Navigation Order 2016 ("**ANO**"), as amended, is a set of regulations established by the CAA that implements the UK's obligations under the convention on international civil aviation and regulates aspects of aviation safety. The ANO largely contains overarching obligations which are subject to more detailed requirements, usually set out in Civil Aviation Publications ("**CAPs**").

A8.13 Article 77 of the ANO requires relevant aircraft to be equipped with the equipment in Schedule 5. That equipment is identified by reference to relevant functions and processes and there is no requirement to install Inmarsat Satcom.[325]

UK Basic Regulation

A8.14 UK Regulation (EU) 2018/1139 is known as the UK Basic Regulation and incorporates the former EU Regulation into UK law. It sets out rules applicable to goods, persons and organisations involved in civil aviation activity and aims to establish and maintain a high uniform level of civil aviation safety in the UK.

A8.15 While there are no specific requirements relating to Inmarsat's Satcom, Annex V states that:

[325] Article 78 of the 2016 version set out the requirements relating to minimum equipment although this was revoked by the Air Navigation (Amendment) Order 2017. Minimum equipment lists are referred to in the UK Air Operations Regulation discussed below.

a) "A flight must not be commenced unless it has been ascertained by reasonable means available that … [all navigation, communication and other equipment] required for the execution of that flight are installed in the aircraft and are operative, unless waived by the applicable [Minimum Equipment List] or equivalent document".[326] We discuss Minimum Equipment Lists below.

b) "Before each flight or a series of consecutive flights, the aircraft must be inspected, through a pre-flight check, to determine whether it is fit for the intended flight."[327]

UK Air Operations Regulation

A8.16 UK Regulation (EU) No. 965/2012 is known as the UK Air Operations Regulation and incorporates the former EU Regulation into UK law.

A8.17 It sets out rules on inspections of aircraft under the safety oversight of another State when landed at UK airports as well as rules relating to aircraft operator certificates.

A8.18 Article 9 refers to Minimum Equipment Lists ("**MEL**") for aircraft which must be established based on the manufacturers' Master Minimum Equipment List ("**MMEL**").[328]

A8.19 Importantly, the MEL is not a list of all equipment that must be present and operational on an aircraft. Rather, the MEL "is a document that lists the equipment that may be temporarily inoperative, subject to certain conditions, at the commencement of flight."[329]

A8.20 The UK Air Operations Regulation explains this is because "Most aircraft are designed and certified with a significant amount of equipment redundancy, such that the airworthiness requirements are satisfied by a substantial margin. In addition, aircraft are generally fitted with equipment that is not required for safe operation under all operating conditions".[330]

A8.21 In fact, it is "All items related to the airworthiness, or required for the safe operation, of the aircraft and not included in the [MEL that] are automatically required to be operative".[331]

A8.22 The Regulation goes on to explain that: "The MEL is an alleviating document having the purpose to identify the minimum equipment and conditions to operate safely an aircraft having inoperative equipment. Its purpose is not, however, to encourage the operation of aircraft with inoperative equipment. It is undesirable for aircraft to be dispatched with inoperative equipment and such operations are permitted only as a result of careful analysis of each item to ensure that the acceptable level of safety, as intended in the applicable

[326] UK Basic Regulation, Annex V, paragraphs 2(c)(iii) and 5.1.
[327] UK Basic Regulation, Annex V, paragraph 6.2.
[328] Article 9 of the UK Air Operations Regulation explains that MELs must be made in compliance with point ORO.MLR.105 of Section 2 of Annex III.
[329] UK Air Operations Regulation, p. 414, GM1 ORO.MLR.105(a), "General", point (a); This paragraph explains that the MEL "is prepared by the operator for their own particular aircraft taking account of their aircraft configuration and all those individual variables that cannot be addressed at MMEL level, such as operating environment, route structure, geographic location, aerodromes where spare parts and maintenance capabilities are available, etc., in accordance with a procedure approved by the CAA".
[330] UK Air Operations Regulation, p.414, GM1 ORO.MLR.105(a), "Non-Safety-Related Equipment", point (a).
[331] UK Air Operations Regulation, p.414, GM1 ORO.MLR.105(a), "Non-Safety-Related Equipment", point (b).

airworthiness and operational requirements is maintained. The continued operation of an aircraft in this condition should be minimised."[332]

A8.23 While Inmarsat Satcom may appear on an MEL, there is therefore no legal requirement for that equipment to be operative prior to take-off. We understand it may however be best practice and/or an operational requirement to demonstrate Inmarsat Satcom is operative prior to take-off, particularly for flights in the North Atlantic region.[333]

UK Continuing Airworthiness Regulation

A8.24 UK Regulation (EU) No. 1321/2014 is known as the UK Continuing Airworthiness Regulation and incorporates the former EU Regulation into UK law.

A8.25 It sets out requirements for the continuing airworthiness of aircraft including maintenance programmes and checks. In particular, it requires the rectification of any defect and damage affecting safe operation of equipment on the Minimum Equipment List.

ICAO initiatives

Future Air Navigation System ("FANS")

A8.26 FANS 1/A is a type of data link system which allows for the safe separation of aircraft in remote airspace when out of range of terrestrial communications. We understand that Inmarsat's MSS terminals are used to operate the FANS 1/A system.[334]

A8.27 In the North Atlantic region (used for flights from Europe to/from North America), ICAO has published guidance in the North Atlantic Operations and Airspace Manual ("**Manual**")[335] which states that aircraft should have FANS 1/A capability if they wish to use the preferred aircraft tracks and altitudes above 29,000 ft in the North Atlantic region.[336] This is known as the North Atlantic Data Link Mandate ("**NAT DLM**").

A8.28 The Manual explains that other means of communication (such as VHF) are generally unavailable in the North Atlantic region although communications via CPDLC are available to FANS equipped aircraft in most of the airspace.[337] It goes on to say that the NAT DLM requires aircraft to be equipped with, and operating, CPDLC in the North Atlantic region.[338] For this reason, we understand "FANS equipment is typically included in the MMEL for aircraft which will operate on FANS routes and in the MEL for the airline."[339]

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[332] UK Air Operations Regulation, p. 418, GM2 ORO.MLR.105(d)(3); The UK Air Operations Regulation also explains that the MEL applies before dispatch (i.e. before the plane pushes back under its own power). After that, the pilot can still refer to the MEL although any decision to continue with the flight will ultimately be subject to pilot judgement and good airmanship (see p. 417, AMC1-2 ORO.MLR.105(d)(3).

[333] See sub-section on the Future Air Navigation System from paragraph A8.26. Also see ECC Report 299, section 3.1.

[334] ECC Report 299, section 3.1.

[335] At the time of this consultation, the North Atlantic Operations and Airspace Manual was last updated in March 2024.

[336] Manual, section 1.8; ECC Report 299, section 3.1.

[337] Manual, Foreword.

[338] Manual, section 1.8.1.

[339] ECC Report 299, section 3.1.

A8.29 The Manual also explains that if a flight experiences an equipment failure prior to departure which renders the aircraft non-NAT DLM compliant, the flight should re-submit a flight plan, to remain clear of the NAT regional DLM airspace.[340]

A8.30 We understand FANS and the NAT DLM therefore effectively impose an operational requirement on flights departing for the North Atlantic region to check their Satcom equipment is working prior to departure from airports.

IRIS Project

A8.31 Iris is also a type of data link system, funded and promoted by the European Space Agency ("**ESA**") in partnership with Inmarsat and industry. It has been developed with the aim of making aviation safer and more efficient by developing a new satellite-based air-ground communication system for air traffic management.[341]

A8.32 Iris service deployment has included upgrades to ground stations and requires the installation of Iris-capable satellite communication equipment on commercial flights operating within the European airspace.

A8.33 Iris equipment is not currently mandated for the use of certain aircraft tracks and altitudes in the European airspace, in the way that FANS is for the North Atlantic airspace. However, the ICAO states that specific requirements are currently being developed, which suggests that demonstration of the functioning of Iris equipment prior to departure may be required in the future. The ESA have stated that by 2028, Iris will be well placed to "enable flight optimisation across the globe and the datalink will become the primary means of communications between pilots and air traffic controllers".[342]

Proposed airports for protection

A8.34 For the reasons set out in paragraphs 3.84-3.90, we propose to protect the following international commercial airports.

Figure A8.1: Airports that we propose to protect[343]

Airports that we propose to protect		
Aberdeen	Edinburgh	Manchester
Belfast City (George Best)	Exeter	Newcastle
Belfast International	Gatwick	Newquay
Biggin Hill	Glasgow	Norwich
Birmingham	Heathrow	Prestwick

[340] Manual, section 1.8.4; This section also explains what happens when data link equipment fails after departure and within the NAT DLM airspace. Sections 5.1.32 – 5.1.35 set out additional guidance relating to data link communications.
[341] ECC Report 299, section 3.1; ESA, Iris for aviation.
[342] ESA, Iris for aviation.
[343] We have compiled this list from Table 12.1 'International Air Passenger Traffic', available on the CAA's website.

Blackpool	Humberside	Southampton
Bournemouth	Inverness	Southend
Bristol	Leeds Bradford	Stansted
Cardiff Wales	Liverpool (John Lennon)	Sumburgh
City Of Derry (Eglinton)	London City	Teesside International Airport
East Midlands International	Luton	

When would it be appropriate to move to Phase 2 PFD limits

A8.35 As set out in Section 3, paragraphs 3.91-3.100, we have considered two high level options for reducing the PFD limits from the Phase 1 to the Phase 2 levels:

a) **Option A**: An accelerated upgrade process over a relatively short Phase 1 period, around five years from the date of our final decision. In order to avoid the risk of blocking once restrictions are relaxed to Phase 2 levels, we would expect airlines to upgrade the Inmarsat receivers most at risk within the specified period; or
b) **Option B**: A natural retirement and upgrade process, taking up to 20 years to transition from Phase 1 to Phase 2 restrictions, starting from the date of our final decision. In order to avoid the risk of blocking, we would expect airlines to upgrade the Inmarsat receivers most at risk from blocking within the specified period, most likely at the point that the affected terminal would naturally be retired.

Option A – approximately five years

A8.36 This option takes into account a range of factors including:

a) Our analysis of the data Viasat was able to provide (which has not been confirmed by Viasat) suggests that a significant proportion of aircraft terminals currently in circulation are made by Honeywell and Cobham, who have developed updated Diplexer/Low Noise Amplifier (DLNA) modules to allow many of their satellite terminals to operate in the presence of adjacent band IMT. We therefore understand it is possible to upgrade the DLNA module on these terminals without modification to the fuselage. Doing so would improve receivers' resilience, such that they are unlikely to be susceptible to mobile interference if Phase 2 protections are in place. We understand this upgrade could be conducted during a normal three-year maintenance cycle.[344]
b) Our assessment of the impact of a relatively short protection period is that the incremental costs would be low and would be outweighed by the benefits (see paragraph A5.37-A5.45). More generally, we understand that the cost of an upgraded

[344] [CONFIDENTIAL ✂]

terminal is low relative to the overall cost of an aircraft, and that, as it is a secondary piece of equipment, the cost of a DLNA filter is even lower.[345]

c) Regardless of the type of upgrade that may be required, we consider it reasonable to assume it would take approximately one year for Inmarsat and/or equipment manufacturers to carry out the necessary testing and/or for affected airlines to become aware of the need to upgrade and then a further 1-3 years for those airlines to arrange for their equipment to be upgraded in accordance with the normal maintenance cycles. Depending on where the maintenance cycle falls within that 1-3 year period, that leaves a further 1-3 years for the upgrade to be certified by the CAA.[346] The longer length of normal maintenance cycles may also help spread the upgrades over a longer period and reduce the risk of a lack of engineers or resources within the CAA to complete the necessary steps. It is also of course open to Inmarsat and equipment manufacturers to start carrying out testing as soon as possible and not to wait until we issue our statement at the end of this consultation process.

d) As explained above, we have not been able to obtain data on the level of resilience of the Inmarsat terminals which are installed on aircraft,[347] and it is therefore possible that many receivers are already resilient at Phase 2.

e) In a worst-case scenario (i.e. where all Inmarsat aviation receivers need to be upgraded), approximately 13,000 receivers would need to be upgraded. Assuming that (i) it would take approximately one year for Inmarsat and/or equipment manufacturers to carry out the necessary testing and/or for affected vessel owners to become aware of the need to upgrade, and (ii) upgrades take place for 50 weeks of each year, this would equate to 65 receivers per week and approximately 2 receivers per week for each of the 32 commercial international airports we intend to protect. We do not consider these figures to be unrealistic and in any event:

   i) These figures are likely to be lower as they presume that Inmarsat has never supplied any airline with a receiver that is resilient to blocking at Phase 2.

   ii) The number of aircraft that will need to be upgraded will be lower as we know that some aircraft have installed more than one MSS receiver.[348]

   iii) Upgrades would not be restricted to UK airports and the resources required to upgrade equipment could be spread across airports worldwide. This should mitigate any potential resourcing or availability issues within the UK.

f) Many receivers may have already been, or would be, upgraded in any event to comply with requirements under Project Iris, and/or to avoid potential disruption as a result of other countries moving to more limited Phase 2 protections earlier than we would propose or because they would have reached their end of life.[349]

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[345] See footnote 196.
[346] [CONFIDENTIAL ✂]
[347] [CONFIDENTIAL ✂]
[348] [CONFIDENTIAL ✂]
[349] ECC Report 299, section 4.3. We also note that ICAO has encouraged the aeronautical industry to improve the resilience of aeronautical L-band MES receivers to tolerate a -30 dBm blocking level for MES operating

g) ICAO initiatives (such as Project Iris) as well as other countries moving to more limited Phase 2 protections earlier than we would propose are also likely to encourage manufacturers to accelerate production of more resilient equipment.[350]

h) Following extensive consultation, the ECC Report suggested a period of 5-7 years for moving to Phase 2[351] and at the time of consulting, no other country has suggested any longer timeframe.[352] One country, Denmark, imposed a shorter timeframe of less than five years.[353]

i) The significant adverse impact of a longer transition period on achieving optimal use of spectrum, efficient use of the upper 1.4 GHz band for IMT and the ongoing economic and consumer benefits that is likely to bring. We consider it would be inefficient to allow investment and improvements in the quality in mobile phone services used by millions of consumers to be held back by outdated technology in some MSS terminals while up to date more resilient alternatives are available.

Option B – up to 20 years

A8.37 This option would take into account the possibility that a longer period of up to 20 years may be appropriate if airlines are not made aware of the need to upgrade their receiver(s) (for example, by Inmarsat) or otherwise decide not to take any action.

A8.38 In this scenario, affected receivers would only be upgraded when existing receivers reach the end of their life. We have suggested up to 20 years taking into account responses to the CFI and subsequent discussions with stakeholders. We also note that ECC Report 299 explains that "the useful economic life of a commercial vessel is approximately 20-30 years, where vessels are scrapped from service with most of the initial equipment they were delivered with".[354]

A8.39 We have not identified any other reasons to favour a longer period of up to 20 years but welcome evidence on why a longer period may be necessary.

A8.40 Under this option, mobile networks would need to constrain their deployment of the spectrum for a period of 20 years, delaying the benefits to mobile consumers for approximately 15 years (compared to Option A).

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above 1520 MHz, noting that this blocking level has been taken as the reference in Europe for putting in place less stringent protection measures for resilient L-band MES (ICAO Information Note). Furthermore, other international administrations have indicated that they will transition to Phase 2 limits within the next few years. SDFI (the Danish regulator) has set 1st January 2025 (SDFI, HØRINGSNOTAT, p. 17) and BMF (the Austrian administration) has set 1st January 2028 (RTR, Anlage zum Bescheid F 1/16-394 der Telekom-Control-Kommission vom 19.10.2020, p. 7).

[350] ICAO has stated that "as of beginning-2024, some aeronautical L-band MES satcom manufacturers are in the process of designing MESs that comply with the revised blocking requirement" (ICAO Information note, Frequency Spectrum Management Panel, 18th working group meeting of 6-16 February 2024, A5.2).

[351] ECC Report 299, section 4.5.

[352] Austria auctioned the spectrum in 2020 and set a deadline of 1 January 2028 for the move to Phase 2 (RTR, Anlage zum Bescheid F 1/16-394 der Telekom-Control-Kommission vom 19.10.2020)

[353] Denmark, which auctioned the spectrum in 2021, only protected international airports and set a deadline of 1 January 2025 for the move to Phase 2. (SDFI, HØRINGSNOTAT, p. 17).

[354] ECC Report 299, section 4.3.

A9. Draft award licence

Available as a separate document on Ofcom's website.

A10. Draft Coordination Procedures

Definitions:

- **"BW"** means bandwidth in MHz.
- **"dBW"** and **"dBm"** mean decibels relative to 1W or 1mW, respectively.
- "**Coordination Zone**" means the zones surrounding protected ports and airports within which mobile base station deployments are required to have coordination calculations performed. These zones are identified in the accompanying shapefiles [355] to these procedures ("**the shapefiles**").
- **"deploy"** or **"deployment"** means any new or modified mobile deployment for supplemental downlink (SDL) transmissions in the 1492-1517 MHz band.
- "**Licensee**" means a holder of a Spectrum Access Licence authorising use of spectrum in the 1492-1517 MHz range.
- **"PFD limited zone"** means the zones surrounding protected ports and airports within which mobile power flux density (PFD) must be kept below defined limits. These zones are identified in the shapefiles.
- **"protected ports and airports"** means certain ports and airports which Ofcom has determined it is appropriate to protect from mobile interference and which are identified in Annexes [X][356] of Ofcom's decision dated […].

A10.1 Licensees wishing to deploy a base station using 1492-1517 MHz must check whether the area in which they want to deploy falls within a PDF limited zone or a Coordination Zone as defined in the shapefiles.

A10.2 Deployments within PFD limited zones are not permitted.

A10.3 If the proposed deployment does fall within a Coordination Zone, the Licensee must follow the procedures set out in this document before deploying.

A10.4 If the proposed deployment does not fall within a Coordination Zone, the Licensee may go ahead with the deployment.

A10.5 For all proposed deployments within a Coordination Zone, Licensees must check whether the protection thresholds set out in Table A10.1 would be exceeded in the relevant PFD limited zone(s) as a result of any proposed new or modified deployment. To do so, the Licensee will need to calculate PFD generated by the deployment within the relevant PFD limited zone(s).

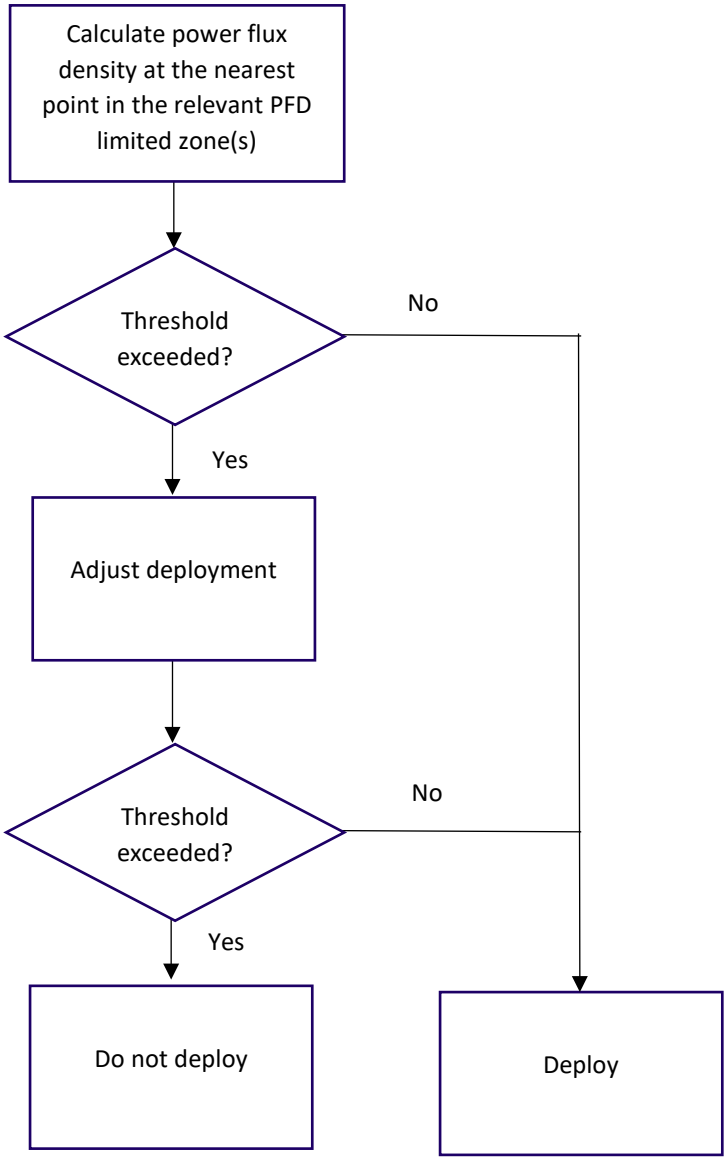
A10.6 If these calculations show that the relevant threshold(s) will not be exceeded in the relevant PFD limited zone(s) as a result of the planned deployment, then deployment can go ahead. If the calculations show that the relevant threshold(s) would be exceeded as a result of the

[355] We have highlighted in yellow any references which we are not including at this stage. In the case of the references to any annexes, this is because we are consulting on the proposed list of areas requiring protection, which will be included in the relevant annex when we publish our final decision. A list of the ports and airports we propose to protect are listed in Annexes A7 (paragraph A7.62) and A8 (at paragraph A8.34).

[356] The ports and airports we propose to protect at listed in A7 (paragraph A7.62) and A8 (at paragraph A8.34)

planned deployment, the Licensee must adjust the deployment and ensure the relevant threshold(s) are not exceeded in the relevant PFD limited zone(s) prior to deployment. This process is illustrated in Figure A10.1 below.

Figure A10.1: Flowchart illustrating coordination procedures



Protected Ports and Airports

A10.7 Details of the PFD limited zones requiring protection are set out in the shapefiles. The Licensee must ensure that its planned deployment complies with the protection thresholds identified in Table A10.1 below in relation to all locations within the PFD limited zone based on the methodology in these procedures.

A10.8 The list of protected ports and airports may be updated and re-issued from time to time. It is the responsibility of the Licensee to ensure that it uses the most recent version when planning its deployment. Where a protected port or airport has been changed, Ofcom will notify the Licensee of the change.

Protection thresholds

A10.9 Table A10.1 contains values for the PFD thresholds to be met for signals within the 1492-1517 MHz band. The Licensee must ensure that emissions from each base station (based on the methodology in these procedures) in the 1492-1517 MHz band do not exceed the thresholds in Table A10.1 at all times.

Table A10.1: Protection thresholds

	Phase 1		Phase 2	
	Threshold for signals in the 1492-1512 MHz band (dBm/5MHz)	Threshold for signals in the 1512-1517 MHz band (dBm/5MHz)	Threshold for signals in the 1492-1512 MHz band (dBm/5MHz)	Threshold for signals in the 1512-1517 MHz band (dBm/5MHz)
Ports	-75.9	-80.9	-31.9	-35.9
Airports	-54.9	-58.4	-31.9	-35.9
The protection thresholds are referenced to a 0dBi receive antenna.				

Coordination zones

A10.10 Coordination calculations should be performed for all mobile deployments that fall into coordination zones defined as follows.[357] Deployments which meet all of the 'small cell' criteria in Table A10.2 will require coordination in a smaller area.

A10.11 Phase 1

a) Protected ports – coordination will be required everywhere that a deployment may cause PFD limits to be exceeded in the relevant PFD limited zones.

b) Protected airports – coordination is required within a 20 km range from the relevant PFD limited zone, or within 10 km for deployments meeting all of the 'small cell' criteria in Table A10.2.

A10.12 Phase 2

a) Protected ports – coordination will be required within a defined area 2 km around each of the PFD limited zones, or within 1 km for deployments meeting all of the 'small cell' criteria in Table A10.2.

b) Protected airports – coordination will be required within a defined area 2 km around each of the PFD limited zones, or within 1 km for deployments meeting all of the 'small cell' criteria in Table A10.2.

[357] [These are provisional definitions subject to considering stakeholder feedback on how these zones should be defined and the outcome of our consultation process.]

A10.13 We note that coordination zones will overlap in some locations, and it will be necessary to perform coordination calculations to multiple different PFD limited zones for base station deployments in these areas.

Table A10.2: Limits for 'small cell' IMT deployments using reduced coordination distances.

Parameter	'Small cell' deployment limits
EIRP in 1492-1512 MHz	58 dBm/5 MHz or less
EIRP in 1512-1517 MHz	48 dBm/5 MHz or less
Antenna height	15m above ground level or lower
Antenna downtilt	6° or more

Compliance with the thresholds

A10.14 Prior to deployment in a Coordination Zone, the Licensee must use the methodology in these procedures to assess whether the protection thresholds specified in Table A10.1 will be exceeded as a result of its planned deployment.

A10.15 The Licensee must ensure that the protection thresholds in Table A10.1 are not exceeded at the closest point within the relevant PFD limited zone(s) set out in the shapefiles using the propagation model described below. When considering whether the protection threshold is exceeded, the Licensee will need to take into account the EIRP of the deployment in the direction of the relevant PFD limited zone and the height of the proposed deployment.

A10.16 The Licensee must maintain records of its calculations and assessments and make these available to Ofcom if required.

A10.17 The Licensee must also ensure they have appropriate systems and processes in place to ensure their deployments in any Coordination Zone continue to comply with the thresholds in Table A10.1 in the relevant PFD limited zone(s).

Propagation Model

A10.18 The propagation loss between the proposed 1.4 GHz deployment and the relevant PFD limited zone will be calculated using Recommendation ITU-R P.452-18 "Prediction procedure for the evaluation of microwave interference between stations on the surface of the Earth at frequencies above 0.7 GHz"[358].

A10.19 The assessment will use a time percentage of 20% as included in Table A10.3 below.

A10.20 Predictions are based on the terrain profile with the addition of clutter along the path (see paragraphs A10.22-A10.25 below.

[358] ITU, Recommendation ITU-R P.452-18.

A10.21 A propagation correction due to clutter shall be applied. This is based on a representative clutter height assigned to each clutter category.

Table A10.3: Propagation parameters to be used in coordination calculations

Time percentage	20%
Sea level surface refractivity, N_0 (N-units)	325
The average radio-refractive index lapse-rate through the lowest 1km of the atmosphere, ΔN (N-units/km)	45
Dry air pressure (hPa)	1013
Temperature (°C)	15.0
Nominal path centre latitude φ (°)	51.0
Clear-air propagation attenuation components included:	Line of sight/Diffraction – Diffraction – Multipath and focussing effects – Gaseous absorption Tropospheric scatter – Gaseous absorption Ducting/Layer reflection – Gaseous absorption
The path centre latitude φ may be selected on a case by case basis, in this case N0 and ΔN should be calculated using the following equations:	$N0 = 328 - (\varphi - 50)$ $\Delta N = 42.5 - 0.25(\varphi - 50$

Terrain

A10.22 Digital terrain map data with ≤50m resolution shall be used. Examples include Siradel "DTM" with 40m resolution, Ordnance Survey "Landform Panorama®" or "OS Terrain® 50" datasets with 50m resolution.

Clutter

A10.23 A digital land classification ("clutter") dataset with ≤50m resolution such as Siradel "DLU" with 40m resolution, "Infoterra 50m clutter" or other equivalent shall be used.

A10.24 The Infoterra dataset identifies 10 different clutter categories. For location variation these are mapped to the required clutter designations with nominal clutter heights and nominal obstacle distances.

A10.25 The default parameters, given in Table A10.4 for nominal clutter heights and nominal obstacle distances are as defined in ITU-R P.452-18. Alternative clutter datasets are permitted if agreed with Ofcom in advance.

Table A10.4: Clutter code mapping

Siradel Clutter code and description	Profile clutter height (m)	Infoterra clutter code and Description	Nominal clutter height (m)	Nominal obstacle distance (km)
1. Sea	N/A	6. Water	N/A	N/A
2. River	N/A		N/A	N/A
3. Lake	N/A		N/A	N/A
4. Open	N/A		N/A	N/A
5. Low Density Vegetation	N/A	0.Open 4. Open in Urban	4	0.1
6. High Density Vegetation	15	5.Forest	15	0.05
7. Park	15	8.Park Recreation	4	0.1
8. Village	10	3.Villages	5	0.07
9. Residential	10	1.Suburban	9	0.025
10. Dense Residential	10		12	0.02
11.Urban	15		20	0.02
12.Mean Dense Urban	15		25	0.02
13.Dense Urban	15	7.Dense Urban	25	0.02
14.High Dense Urban	20		35	0.02
15.Building Blocks	15		9	0.025
16.Industrial	15	10.Industry	20	0.05
17.Airport	N/A		N/A	N/A

A11. Example PFD Limited Zones

Airports

Figure A11.1: Glasgow International Airport

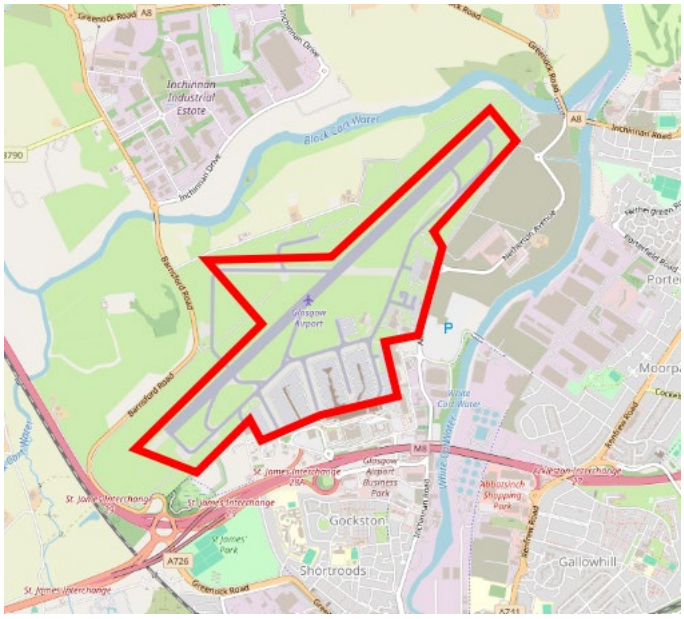


Figure A11.2: Belfast International Airport

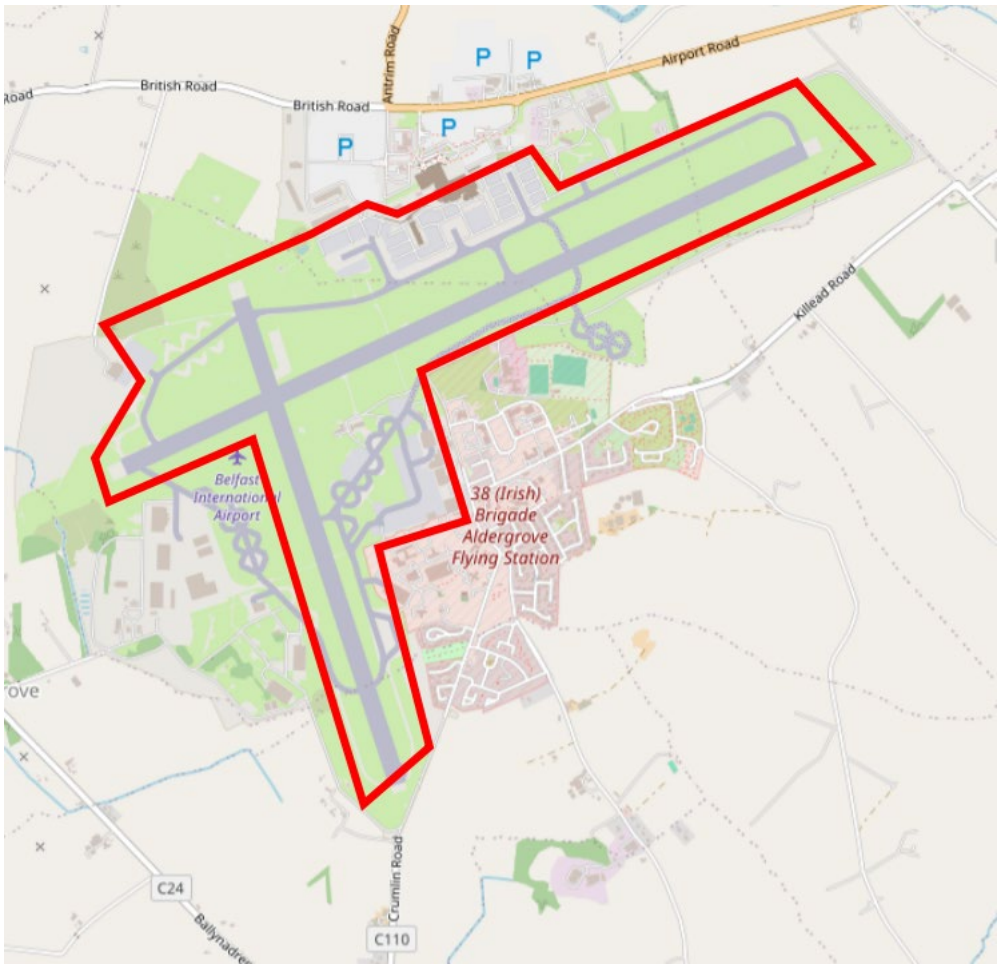
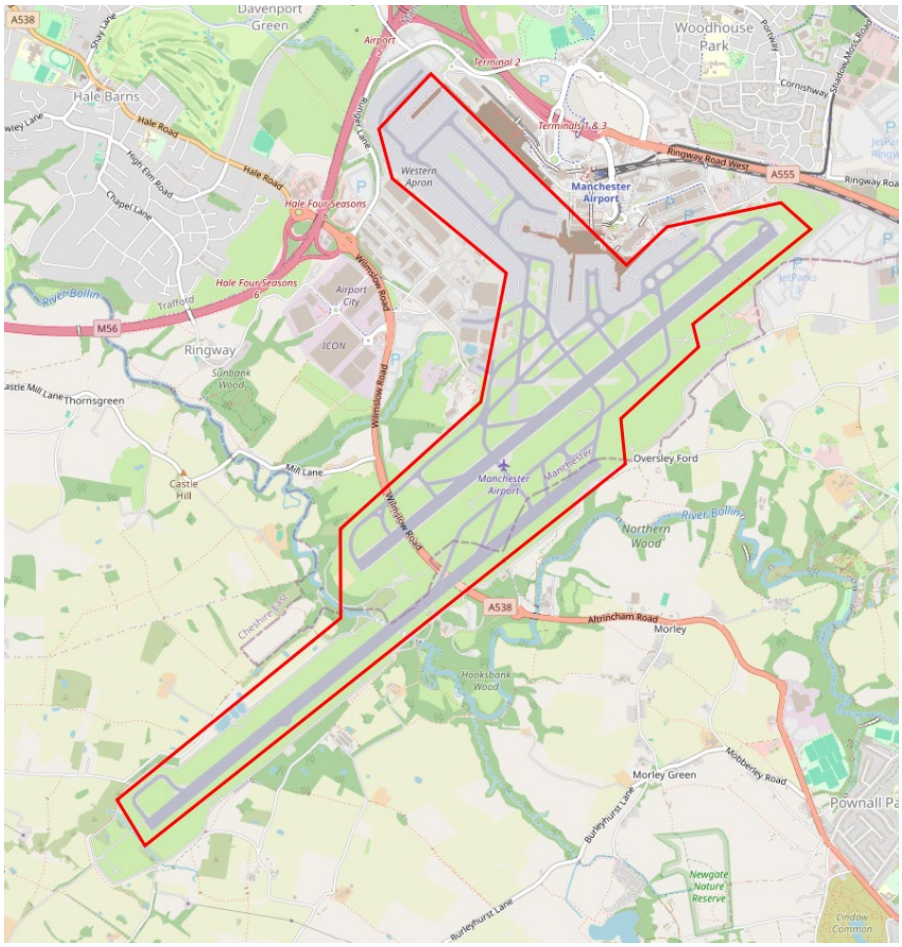


Figure A11.3: Manchester International Airport



Ports

Figure A11.4: Thames Estuary

Figure A11.5: Immingham, Grimsby and the Humber Estuary

A12. Draft interface requirements

Available as a separate document on Ofcom's website

A13. Illustrative auction procedures

A13.1 As part of our work on the proposed award process, we have prepared illustrative procedures, which are set out in this annex. As noted in Section 8, these are an initial draft and are being shared as part of this consultation so that stakeholders can obtain a more in-depth understanding of our proposed auction design. The procedures are evolving, and it is quite likely that there will be changes, both in light of consultation responses and when we commence work on implementing these processes in a statutory instrument. Nevertheless, we consider it helpful to share our current thinking with stakeholders and we welcome any comments and suggestions on this as part of our consultation.

Applications, initial deposit and qualification

A13.2 Applicants would be required to provide Ofcom with certain information in order to apply to participate in the auction. The type of information, the form of submission and the deadline will be specified by Ofcom closer to the time of the auction.

A13.3 Along with their application, applicants would be required to submit an initial monetary deposit of £1m, which might be forfeited in whole or in part if the applicant subsequently breaches the Auction Regulations. Any interest on deposits would be retained by Ofcom and passed to HM Treasury.

A13.4 After the deadline for applications, Ofcom would notify each applicant of the name of every other applicant and its "associates" (i.e. every person having a material interest in the other applicants). Applicants would then need to ensure they meet the auction rules which would not allow for two or more associated applicants to participate in the auction (the "**bidder association rules**"). They would need to do so by a deadline specified by Ofcom, and it may be the case that some applicants have to withdraw their application to prevent another applicant from failing to qualify in the auction. Other qualification criteria to ensure that applicants are suitable to hold a licence would also apply. The provisions for qualification are similar to those used in recent awards by Ofcom and will be specified in the regulations made by Ofcom setting out the auction rules (the "**Auction Regulations**").

A13.5 After the deadline for complying with the bidder association rules, Ofcom would determine which applicants qualify to participate in the auction.

A13.6 To do so, Ofcom may require additional information from specific applicants, which would need to be provided before a deadline specified by Ofcom.

A13.7 Ofcom would also notify applicants of the last day for withdrawal from the award process, i.e. the deadline by which applicants who wish to withdraw their application can do so without losing their initial deposit.

A13.8 Following the last day for withdrawals from the award, Ofcom would determine the list of qualified applicants (i.e. bidders) and return the initial deposit to any applicants who fail to qualify or any applicant who qualified as a bidder but withdrew their application within the specified timeframe.

A13.9 Only qualified applicants would be allowed to participate in the auction.

Overview

A13.10 In Section 8, we have proposed to award the spectrum using a sealed bid, single round auction with a second price rule. Bidders would be presented with different bidding options. Bidders would place bids on their preferred options, and Ofcom would determine the winning bids by identifying the highest value combination of bids which could be accommodated by the lots in the auction.

A13.11 After determining the winning bids, Ofcom would calculate the price to be paid by each bidder that has won spectrum.

A13.12 The following sections set out further information on the award, as well as an illustrative example of the sealed bid single round mechanism.

The Electronic Auction System

A13.13 We propose to run the auction over the internet using an Electronic Auction System ("**EAS**"). No specialist hardware or software would be required on bidders' terminals, as the EAS interface would run on a standard web browser.

A13.14 Ofcom also expects to make a stand-alone version of the software available to applicants, a few days after application. Applicants would be able to login both as bidders and as the auctioneer, allowing them to run internal mock auctions as part of their training.

A13.15 This EAS would be a simpler auction system than Ofcom intends to use for the mmWave award[359] and it would have the following characteristics:

a) The process would comply with the Auction Regulations in full.

b) Bids would be submitted in a secure way and by all bidders simultaneously (within the same time window specified by Ofcom).

c) The EAS would validate bids before it allows the bids to be submitted to Ofcom (for example, to ensure that no bid is submitted at a price below the reserve price or for a bidding option which is not available to bidders).

d) The processes to select the winning outcomes and to determine the prices to be paid by winning bidders are in accordance with the Auction Regulations and any random selection is truly random.

A13.16 We believe that the use of an EAS for this award would ensure that the process is transparent and runs smoothly, and that it would help limit the risk that bidders make mistakes when submitting their bids.

[359] See Ofcom's 16 April 2024 Statement "Enabling mmWave spectrum for new uses" for the latest publication on the mmWave award.

Sealed bid single round auction

Bidding options

A13.17 Each bidder would be presented with the five bidding options shown in Table A13.1 below. The green portion in each option represents the range of frequencies which would be authorised by a licence offered in the award.

Table A13.1: Bidding options available to each bidder in the award.

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option 1					
Option 2					
Option 3					
Option 4					
Option 5					

Bids

A13.18 During the round, each bidder would have the opportunity to express their preferences for the bidding options in Table A13.1 by placing bids.

A13.19 A bid consists of:

a) a bidding option; and

b) a bid amount, specified in pounds, and which must be in whole thousands and at least equal to £1m (i.e., the reserve price per 5 MHz)[360] multiplied by the number of 5 MHz lots comprised in the bidding option.[361]

A13.20 Submitting a bid establishes a commitment to pay a price that would not exceed the bid amount in the event that the bid is determined to be a winning bid.

A13.21 Ofcom would be deemed to have bid for all bidding options at the reserve price.[362] This means that bidders will only be able to win an option for which they have placed a bid equal to or above the reserve price.

A13.22 Bidders must submit bids (as specified in A13.19) for at least one of the bidding options set out in Table A13.1. Failure to do so would result in the bidder not taking part in the award and the forfeiture of their initial monetary deposit.

[360] As specified in Section 8, paragraph 8.4, we propose that reserve prices should be £1m per 5 MHz.
[361] For example, for bidding option 1, the bid amount must be at least equal to £2m.
[362] Ofcom would therefore be deemed to have placed the following bids: (i) a bid of £2m for Option 1; (ii) a bid of £3m for Option 2; (iii) a bid of £5m for Option 3; (iv) a bid of £1m for Option 4; (v) a bid of £4m for Option 5.

A13.23 Bidders do not have to submit bids for each bidding option.

A13.24 Box A13.1 below provides an example of bidding during the award.

Box A13.1: Example of bidding during the award

Suppose there are two bidders (X and Y) participating in the award.

The reserve price for each 5 MHz of spectrum is £1m.

Each bidder is presented with the bidding options shown in Table A13.1 above.

Bidders X and Y submit their bids. These are shown in Table A13.2 and Table A13.3 respectively, with bidder X's bids shown in yellow, and bidder Y's in red.

An option without a bid means that the bidder chose not to submit a bid for it.[363]

Table A13.2: Bids submitted by bidder X in the award.

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option 1	£40m				
Option 2					
Option 3	£60m				
Option 4	£20m				
Option 5					

Table A13.3: Bids submitted by bidder Y in the award.

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option 1					
Option 2			£30m		
Option 3	£90m				
Option 4					
Option 5		£40m			

[363] See, for example, option 2 in Table A13.2 Bidder X has not bid for that particular option.

Permissible band plans

A13.25 Ofcom would arrange all bids into a set of "permissible band plans". These represent all of the possible combinations of allocations of specific frequencies which ensure that:

a) each bidder is assigned a range of frequencies which corresponds to a bidding option for which it has submitted a bid; and

b) each permissible band plan contains at most one of any bidder's bids.

A13.26 Box A13.2 below provides an example of permissible band plans.

Box A13.2: Example of permissible band plans

Suppose that only two bidders (X and Y) participate in the award, and that they have submitted the bids shown in Table A13.2 and Table A13.3.

Ofcom arranges all bids into a set of permissible band plans. These are shown in Table A13.4 below, with bidder X's bids shown in yellow, and bidder Y's in red. The blank spaces represent unsold spectrum and thus we interpret it as Ofcom having submitted a bid at the reserve price (i.e., £1m multiplied by the number of 5 MHz lots included in the bidding option).

Table A13.4: Permissible band plans.

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Band Plan A	£40m		£30m		
Band Plan B	£60m				
Band Plan C	£90m				
Band Plan D	£20m	£40m			
Band Plan E	£40m		£3m		
Band Plan F	£2m		£30m		
Band Plan G	£20m	£4m			
Band Plan H	£1m	£40m			
Band Plan I	£5m				

Determination of the winning outcome

A13.27 To determine the winning outcome, Ofcom would sum up the bid amounts of the valid bids in each permissible band plan. The winning outcome would be the permissible band plan that yields the greatest sum of valid bid amounts.

A13.28 For example, if the permissible band plans were those shown in Table A13.4, the winning outcome would be Band Plan C as this produces the greatest sum of valid bid amounts (i.e., £90m).

A13.29 If there are multiple permissible band plans that yield the greatest value, the winning outcome would be selected at random amongst the permissible band plans that yield that value.[364]

Determination of the prices to be paid by winning bidders

A13.30 The prices to be paid by winning bidders will be based on nearest-Vickrey pricing, which we detail below. This is the same pricing method used for the assignment stages in previous auctions, e.g., the award of 700 MHz and 3.6 – 3.8 GHz, the award of 2.3 GHz and 3.4 – 3.6 GHz, and the award of 800 MHz and 2.6 GHz.

Price calculation based on the nearest-Vickrey pricing

A13.31 The first step in finding the price to be paid by winning bidders is to calculate the Vickrey prices. A bidder's Vickrey price is the opportunity cost of its winning bid; it is the smallest amount the bidder could have bid without being displaced by an alternative permissible band plan with a higher total value of bids. This amount is found by:

a) Setting the bidder's non-winning bids to zero.

b) Reducing the bidder's winning bid until an alternative plan has the same total value.

c) Identifying the Vickrey price as the greater of the reserve price (i.e., £1m multiplied by the number of 5 MHz lots included in the bidding option) and the reduced bid value calculated in (b).

A13.32 Steps (a), (b) and (c) are repeated for each winning bid.

A13.33 In many circumstances, the Vickrey prices are the prices to be paid by the winning bidders.

A13.34 However, sometimes, the sum of the Vickrey prices is less than the total value of an alternative plan (i.e. there is a 'shortfall"). This shortfall implies one or more bidders are willing to pay more for an alternative plan than the sum of the Vickrey prices. A shortfall arises due to complementarities in bidding, e.g. two smaller bidders outbid a larger bidder for a location.

A13.35 In such a case, the Vickrey prices are increased for some or all winning bidders. These 'additional prices' satisfy the following four requirements.

A13.36 **First requirement**: Each bidder's price is between £1m (the reserve price for a 5 MHz lot) multiplied by the number of 5 MHz lots in its winning bid, and its bid amount.

[364] This applies to all cases except in the case of multiple permissible band plans yielding the greatest value of £5m (the reserve price for the whole 25 MHz). In such scenario, the winning outcome would be selected at random amongst the permissible band plans in which at least 5 MHz are assigned to a bidder. For example, suppose that there is a single bidder (bidder A) participating in the award. Bidder A bids £2m for Option 1 shown in Table A13.1. Thus, all permissible band plans would yield the greatest value of £5m (as Ofcom would be deemed to have bid for all options at the reserve price). In this case, the winning outcome would be the one assigning Option 1 to bidder A (that is, the permissible band plan yielding the greatest value amongst the permissible band plans in which at least 5 MHz are assigned to a bidder).

A13.37 **Second requirement**: The sum of additional prices must be sufficiently large such that no winning or non-winning bidder or group of bidders is willing to pay more for an alternative plan (i.e. eliminating the shortfall between the sum of Vickrey prices and the total value of an alternative band plan). In this calculation, winning bids used in alternative plans are included at the price to be paid rather than the bid amount, and non-winning bids are reduced by the difference between the bidder's winning bid amount and the price to be paid.

A13.38 **Third requirement**: If multiple sets of prices satisfy the first and second requirements, Ofcom selects the one that minimises the sum of additional prices.

A13.39 **Fourth requirement**: If there are multiple sets of prices that satisfy the first, second and third requirements, Ofcom selects the one that is closest to the Vickrey prices. Nearest-Vickrey implies that the winners with surplus (i.e. a Vickrey price that is less than their bid) contribute equally to eliminate the shortfall identified in the second requirement[365]. Mathematically, Ofcom minimises the following sum across all bidders through the following formula: $\Sigma(p_X - c_X)^2$, where p_X is the additional price for bidder X,[366] and c_X is the Vickrey price for bidder X.

Example of sealed bid single round auction

A13.40 In this annex, we provide an example of how bid submission and spectrum allocation would work in the award. We also show how the prices to be paid by each winning bidder are calculated. The prices in the Box A13.3 example are without a shortfall (that is, bidders pay the Vickrey prices), whereas the Box A13.4 example has a shortfall calculation and distribution amongst winning bidders (that is, nearest-Vickrey pricing is applied).

Box A13.3: Example of sealed bid single round auction with no shortfall.

Consider 2 bidders (X and Y) and the same set up as the award.

Bidding options

Both bidders will be presented with the bidding options shown in Table A13.5 below.

Table A13.5: Bidding options available to bidders X and Y during the award.

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option 1					
Option 2					

[365] If, when equally distributing the shortfall amongst winners, one winner would end up paying more than its original bid, its additional price would be set at its original bid and the excess would be reallocated amongst the remaining winners.

[366] The additional price which bidder X would be paying after the shortfall is calculated and distributed amongst some (or all) winning bidders.

	MHz				
Option 3					
Option 4					
Option 5					

Bids

During the round, bidders X and Y place their bids on their preferred options. These are shown in Table A13.6 and Table A13.7 respectively, with bidder X's bids shown in yellow, and bidder Y's bids in red.

An option without a bid means that the bidder chose not to submit a bid for it.

Table A13.6: Bidder X's bids.

	MHz				
	1492 - 1497	**1497 – 1502**	**1502 - 1507**	**1507 - 1512**	**1512 - 1517**
Option 1	**£40m**				
Option 2					
Option 3	**£60m**				
Option 4	**£20m**				
Option 5					

Table A13.7: Bidder Y's bids.

	MHz				
	1492 - 1497	**1497 – 1502**	**1502 - 1507**	**1507 - 1512**	**1512 - 1517**
Option 1					
Option 2					
Option 3	**£90m**				
Option 4					
Option 5					

All bids are valid as they are either equal to or greater than £1m (i.e., the reserve price per 5 MHz) multiplied by the number of 5 MHz lots comprised in the bidding option.

Determining the winning outcome

Ofcom will determine which of the permissible band plans yields the highest total value of bids.

Table A13.8 below shows all the permissible band plans for the award. For easy visualisation, we highlight bidder X's range of frequencies and bids within those permissible band plans in yellow, and bidder Y's in red. The blank spaces represent unsold spectrum and thus we interpret it as Ofcom having submitted a bid at the reserve price (i.e., £1m multiplied by the number of 5 MHz lots included in the bidding option).

- Plan A yields a total value of £40m + £3m = £43m.
- Plan B yields a total value of £60m.
- Plan C yields a total value of £90m.
- Plan D yields a total value of £20m + £4m = £24m.

Thus, in this case, the winning outcome is Band Plan C as it yields the highest total value of £90m.

Bidder Y wins frequencies 1492 – 1517 MHz.

Table A13.8: All permissible band plans.

	MHz				
	1492 - 1497	1497 – 1502	1502 – 1507	1507 – 1512	1512 - 1517
Band Plan A	**£40m**		**£3m**		
Band Plan B	**£60m**				
Band Plan C	**£90m**				
Band Plan D	**£20m**	**£4m**			
Band Plan E	**£5m**				

Determining the prices to be paid by each winning bidder

First, we need to find the Vickrey price for each bidder's winning bid. Looking at bidder Y (see Table A13.9), we:

- Reduce all of Y's non-winning bids to 0 (this has no impact, as Y had no other bids besides its winning bid).
- Incrementally reduce bidder Y's winning bid of £90m, until an alternative plan has the same total value as Band Plan C. Y's bid is reduced down to £60m, at which point Band Plan B has the same total value as Band Plan C.
- The Vickrey price for bidder Y is £60m.

Table A13.9: All permissible band plans with Y's reduced bids.

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Band Plan A	**£40m**		**£3m**		

	MHz	
Band Plan B	**£60m**	
Band Plan C	**£60m (reduced, originally £90m)**	
Band Plan D	**£20m**	**£4m**
Band Plan E	**£5m**	

Next, we check whether there is a shortfall caused by Vickrey prices. There is no shortfall since the sum of Vickrey prices (£60m) is either equal to, or higher than any alternative plan (the next highest value alternative plan is Band Plan B with a value of £60m).

Thus, at the end of the bidding process, bidder Y wins frequencies 1492 – 1517 MHz and pays £60m.

Box A13.4: Example of sealed bid single round auction with shortfall.

Consider three bidders (X, Y and Z) and the same set-up of the award as in the previous example.

Bidding options

All bidders will be presented with the bidding options shown in Table A13.10 below.

Table A13.110: Bidding options available to bidders X, Y and Z during the award.

	MHz				
	1492 - 1497	**1497 – 1502**	**1502 - 1507**	**1507 - 1512**	**1512 - 1517**
Option 1					
Option 2					
Option 3					
Option 4					
Option 5					

Bids

During the round, bidders X, Y and Z place their bids on their preferred options. These are shown in Table A13.11, Table A13.12, and Table A13.13 respectively, with bidder X's bids shown in yellow, bidder Y's bids in red, and bidder Z's bids in pink.

An option without a bid means that the bidder chose not to submit a bid for it.

Table A13.11: Bidder X's bids.

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option 1					
Option 2					
Option 3					
Option 4	£20m				
Option 5					

Table A13.12: Bidder Y's bids

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option 1					
Option 2					
Option 3					
Option 4					
Option 5		£30m			

Table A13.13: Bidder Z's bids

	MHz				
	1492 - 1497	1497 – 1502	1502 - 1507	1507 - 1512	1512 - 1517
Option 1					
Option 2					
Option 3	£30m				
Option 4					
Option 5					

All bids are valid as they are either equal to or greater than £1m (i.e., the reserve price per 5 MHz) multiplied by the number of 5 MHz lots comprised in the bidding option.

Determining the winning outcome

Ofcom will determine which of the possible combinations of winning outcomes yields the highest total value.

Table A13.14 below shows all the permissible band plans for the award. For easy visualisation, we highlight bidder X's range of frequencies and bids within those permissible band plans in yellow, bidder Y's in red and bidder Z's in pink. The blank spaces represent unsold spectrum and thus we interpret it as Ofcom having submitted a bid at the reserve price (i.e., £1m multiplied by the number of 5 MHz lots included in the bidding option).

- Plan A yields a total value of £20m + £30m = £50m
- Plan B yields a total value of £30m.
- Plan C yields a total value of £20m + £4m = £24m.
- Plan D yields a total value of £1m + £30m = £31m.
- Plan E yields a total value of £5m.

Thus, in this case, the winning outcome is Plan A as it yields the highest total value of £50m.

Bidder X wins frequencies 1492 – 1497 MHz, while bidder Y wins frequencies 1497 – 1517 MHz.

Table A13.14: All permissible band plans.

	MHz				
	1492 – 1497	**1497 – 1502**	**1502 – 1507**	**1507 - 1512**	**1512 - 1517**
Band Plan A	**£20m**	**£30m**			
Band Plan B	**£30m**				
Band Plan C	**£20m**	**£4m**			
Band Plan D	**£1m**	**£30m**			
Band Plan E	**£5m**				

Determining the prices to be paid by each winning bidder

First, we need to find the Vickrey price for each bidder's winning bid. Starting with bidder X (see Table A13.15), we:

- Reduce all of X's non-winning bids to 0.
- Incrementally reduce bidder X's winning bid of £20m, until an alternative plan has the same total value as Option A. X's bid is reduced down to £1m, at which point Plan D has the same total value as Plan A.
- The Vickrey price for bidder X is £1m.

Table A13.15: All permissible band plans with X's reduced bids.

	MHz				
	1492 – 1497	**1497 – 1502**	**1502 – 1507**	**1507 - 1512**	**1512 - 1517**

	MHz	
Band Plan A	**£1m (reduced, originally £20m)**	**£30m**
Band Plan B	**£30m**	
Band Plan C	**£1m (reduced, originally £20m)**	**£4m**
Band Plan D	**£1m**	**£30m**
Band Plan E	**£5m**	

Applying the same process to bidder Y (see Table A13.16), we:

- Reduce all of Y's non-winning bids to 0.
- Incrementally reduce bidder Y's winning bid of £30m, until an alternative plan has the same total value as Plan A. Y's bid is reduced down to £10m, at which point Plan B has the same total value as Plan A.
- The Vickrey price for bidder Y is £10m.

Table A13.16: All permissible band plans with Y's reduced bids.

	MHz				
	1492 – 1497	**1497 – 1502**	**1502 – 1507**	**1507 - 1512**	**1512 - 1517**
Band Plan A	**£20m**	**£10m (reduced, originally £30m)**			
Band Plan B	**£30m**				
Band Plan C	**£20m**	**£4m**			
Band Plan D	**£1m**	**£10m (reduced, originally £30m)**			
Band Plan E	**£5m**				

Next, we check whether there is a shortfall caused by Vickrey prices. There is a shortfall since the sum of Vickrey prices (£11m) is lower than Plan B. We therefore need to raise the Vickrey prices based on the four requirements.

First Requirement

Bidder X's price must be between £1m (the reserve price for the single lot) and its bid of £20m.

Bidder Y's price must be between £4m (the reserve price for the four lots) and its bid of £30m.

Second Requirement

The sum of additional prices must be sufficiently large that no winning or non-winning bidder or group of bidders is willing to pay more for an alternative plan.

In this case, bidder Z was willing to pay £30m for frequencies 1492 – 1517 MHz. However, bidder X and Y's Vickrey prices sum to £11m. Therefore, the sum of Vickrey prices for X and Y must be raised to at least £30m.

Third Requirement

Ofcom must select the prices that minimise the sum of additional prices.

The sum of additional prices from X and Y must therefore be £30m and no larger. This gives a shortfall of £19m (£30m – £11m).

Fourth Requirement

We split the shortfall equally amongst X and Y, subject to the constraint that no winner pays more than its bid.

Bidder X's additional price is therefore £1m (Vickrey price) + £9.5m (shortfall share) = £10.5m.

Bidder Y's additional price is therefore £10m (Vickrey price) + £9.5m (shortfall share) = £19.5m.

The additional prices of X and Y are below each of their respective bids, so we do not need to reallocate any excess.

Thus, at the end of the bidding process, bidder X wins frequencies 1492 – 1497 MHz and pays £10.5m. Bidder Y wins frequencies 1497 – 1517 MHz and pays £19.5m.

Total auction sum

A13.41 After the end of the bidding process, Ofcom will notify each bidder of the total auction sum payable by them. This is equal, for each bidder, to the prices as calculated in paragraphs A13.31-A13.39.

Deposit

A13.42 By a deadline to be specified by Ofcom, bidders need to have on deposit at least the amount corresponding to the bidder's highest bid.

A13.43 If a bidder does not provide Ofcom with the deposit, all bids in question submitted by the bidder (if any) would be deemed to be invalid.[367] In addition, the bidder would forfeit any money it has on deposit.

[367] This would be done before bid processing, so that the initial bids (before being invalidated) cannot be made winning bids, and cannot affect winning bidders' prices.

Extraordinary events

A13.44 Ofcom retains powers to address extraordinary events that might otherwise compromise the auction, including:

a) suspending the auction;

b) cancelling the auction;

c) cancelling some or all bids submitted by one or more bidders; and/or

d) excluding one or more bidders from the auction.

A13.45 Bidders who breach the Auction Regulations may forfeit part or all of their deposit.

Information released at the end of the auction

A13.46 In Section 8, we ask for stakeholders' input on the information to be released at the end of the auction.

A14. In depth review of all bidding options

A14.1 In Section 8, we set out our proposed spectrum packages on which bidders would be able to bid during the award.

A14.2 In this annex, we explain our reasoning for choosing those packages in detail.

Process to choose the bidding options for the award

A14.3 There are fifteen possible bidding options of one or more 5 MHz lots which would produce contiguous spectrum for all bidders. We show them in Table A14.1 below.

Table A14.1: All possible bidding options which produce contiguous spectrum within the block for all bidders.

	MHz				
	1492 – 1497	1497 – 1502	1502 – 1507	1507 – 1512	1512 – 1517
Option 1					
Option 2					
Option 3					
Option 4					
Option 5					
Option 6					
Option 7					
Option 8					
Option 9					
Option 10					
Option 11					
Option 12					
Option 13					
Option 14					
Option 15					

A14.4 We understand that some bidders may not have strong demand for smaller amounts of spectrum. More specifically, according to Vodafone,[368] bidders would want at least 10 MHz while BT/EE[369] and VMO2[370] do not believe there would be a strong business case for less than 25 MHz of spectrum.

A14.5 However, we understand that Option 1 (a single 5 MHz lot at the bottom of the block) may still be of interest to a bidder such as H3G which holds licences for adjacent frequencies (1472 – 1492 MHz).

A14.6 Removing all bid options where bidders win less than 10 MHz, other than at the very bottom of the band, would reduce the bidding options to eight, split into five possible combinations of winning outcomes. This is shown in Table A14.2 below.

Table A14.2: All possible combinations of winning outcomes which guarantee bidders win at least 10 MHz of spectrum (or a single 5 MHz of spectrum at the bottom of the block)

	MHz				
	1492 – 1497	1497 – 1502	1502 – 1507	1507 – 1512	1512 – 1517
Option A1					
Option A2					
Option B3					
Option C4					
Option C5					
Option D6					
Option D7					
Option E4					
Option E8					
Option E7					

A14.7 In the illustration above, bidding options are indicated by the number, while the combinations of winning outcomes[371] are indicated by the letter. Of the remaining winning outcomes, we believe outcomes D and E to be less likely to be efficient as:

a) Outcome D would mean that a bidder would win the top 10 MHz of the block. This may not lead to an efficient allocation of spectrum, given the restrictions likely to be applied in the top 5 MHz (as set out in Section 6).

[368] Vodafone, CFI response, p. 5.
[369] BT/EE, CFI response, p. 4.
[370] VMO2, CFI response, p. 4.
[371] For simplicity, we only show the combinations of winning outcomes in which all available spectrum is sold.

b) Outcome E means that there would be three spectrum winners in the award. However, this may not lead to an efficient spectrum allocation because excessively fragmented allocations are unlikely to be efficient.

A14.8 We are interested in stakeholders' views on the reasoning set out in paragraph A14.7 above.

A14.9 Taking these factors into account would further reduce the bidding options to five, split into three possible combinations of winning outcomes. This is shown in Table A14.3 below.

Table A14.3: All possible combinations of winning outcomes which guarantee (i) that no bidder wins less than 10 MHz of spectrum, other than the bottom 5 MHz of the band, (ii) a maximum of two winners of spectrum, and (iii) that no bidder wins only the top 10 MHz of the block.

	MHz				
	1492 – 1497	1497 – 1502	1502 – 1507	1507 – 1512	1512 – 1517
Option A1					
Option A2					
Option B3					
Option C4					
Option C5					

A14.10 The options shown in Table A14.3 are those that we consider may lead to an efficient spectrum allocation.