Enabling Satellite Direct to Device services in Mobile spectrum bands

Consultation

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For more information on this publication, please visit
https://www.ofcom.org.uk/spectrum/space-and-satellites/consultation-enabling-satellite-direct-to-device-services-in-mobile-spectrum-bands/

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1. Overview

1.1 This document sets out proposals to authorise the use of spectrum bands used by the UK's Mobile Network Operators (MNOs) for satellite Direct to Device (D2D) services.

1.2 D2D services are designed to provide satellite connectivity to mobile phones in areas not covered by terrestrial mobile networks. They have the potential to increase outdoor geographic coverage and provide a basic backup service in the event of outages on the terrestrial networks.

1.3 We published a Call for Input in July 2024, seeking stakeholders' views on how the introduction of D2D could benefit people and businesses in the UK and whether there are any risks associated with these services. We published a Summary of Responses in November 2024, and said we planned to consult on introducing an authorisation for D2D in mobile bands.

1.4 We consider that enabling these services in the UK could improve connectivity for consumers and businesses, particularly in remote areas; support investment; and open up new opportunities for MNOs (via satellite communications) to use their licensed spectrum holdings more intensively.

What we are proposing – in brief

We are consulting on the ways in which we could authorise D2D satellite services to mobile handsets using most of the spectrum bands licensed to UK MNOs below 3 GHz. Under these proposals:

- D2D services could only be provided by Satellite Operators working with the MNO who is licenced to use the relevant frequencies nationally.
- We are consulting on three potential approaches to authorising mobile handsets to communicate with a satellite in the licenced band(s): (i) a licence exemption; (ii) a variation to the MNO's existing base station licence accompanied by a licence exemption; or (iii) a new licensing regime. We have a preference for option (ii).
- The conditions of any authorisation would require the operator(s) to manage the D2D network in a manner that does not cause harmful radio interference to existing spectrum users in the UK and overseas.
- We will review our approach following the next World Radiocommunications Conference in 2027.

1.5 We invite any comments on these proposals by **5pm on Tuesday 20 May 2025**.

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

2. Background & International developments

2.1 This consultation document presents proposals, including several options for authorisation, to enable Satellite Direct-to-Device (D2D) services in the UK in specific spectrum bands used by the national Mobile Network Operators (MNOs) under national Spectrum Access licences.

2.2 In this document, for brevity, when we refer to D2D we mean direct-to-device services in bands currently utilised for mobile phones/networks (mobile bands). D2D can also be provided in Mobile Satellite Service (MSS) bands; however, these are not in scope for this consultation as there is an existing authorisation framework in place for these services.

2.3 In this section we provide an overview of D2D networks and how we anticipate they could operate in the UK, both technically and commercially, and the international context within which our proposals sit. We then give a high-level summary of our proposals.

Background

2.4 Satellite Direct-to-Device (D2D) services have the potential to provide connectivity to existing, mass-market mobile handsets and other SIM-enabled devices (which we refer to as 'mobile handsets' in this document) in areas that do not have coverage from national terrestrial mobile networks.

2.5 In July 2024, we published a Call for Input, seeking stakeholder views on any potential interest in offering D2D services in the UK and the benefit they could deliver. We considered both mobile bands and Mobile Satellite Service (MSS) bands. We sought to understand industry developments and how new technologies could impact existing MSS markets and encourage further innovation. We also sought views on the timings of any potential D2D authorisations in the UK, in relation to WRC-27.

2.6 We published a summary of the responses, outlining our next steps in November 2024. We received a range of views on the introduction of D2D services in the UK. Stakeholders told us that D2D could improve network resilience and expand coverage; however, some parties were sceptical about the viability of these services. Some responses advocated for the deployment of D2D prior to WRC-27 due to demand and technical readiness, whilst others raised concerns about such an approach. In view of the interest expressed by some parties in launching D2D services in the UK we said we planned to consult on an authorisation framework.

How D2D works

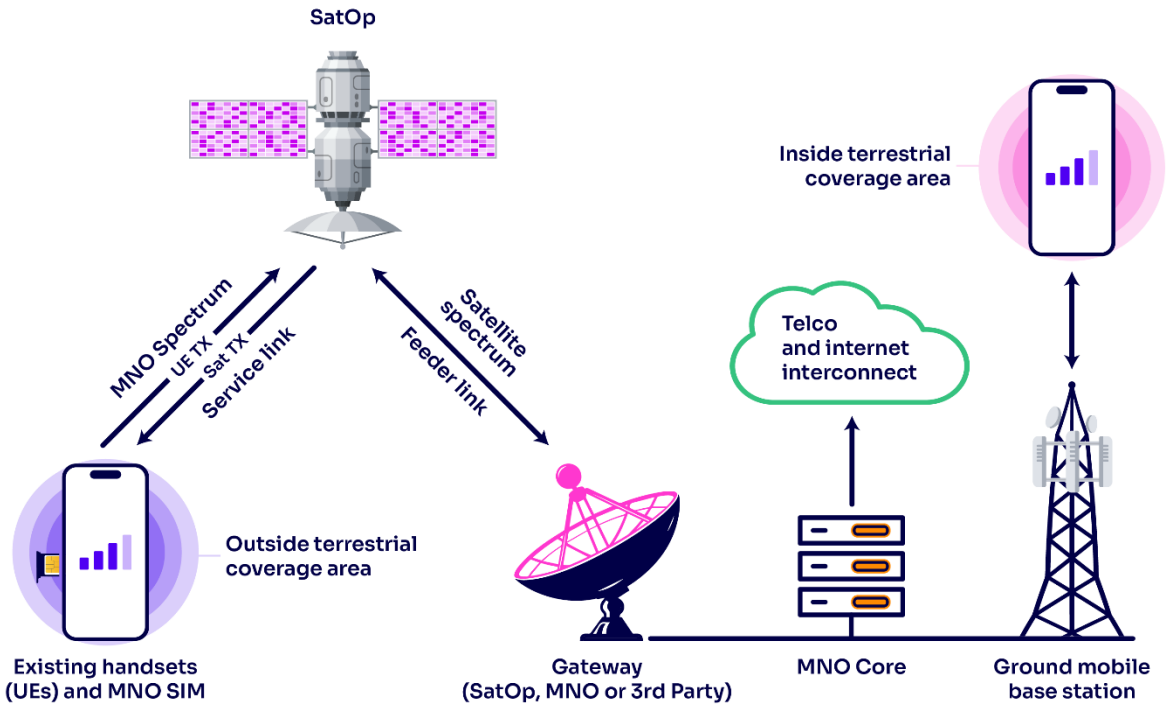
2.7 Handsets could connect to D2D networks when they cannot get a signal from a terrestrial mobile mast. This might be because they are in a permanent 'mobile notspot' or as a result of a temporary outage on the terrestrial network.

2.8 The main components of a D2D network are shown in figure 1; this includes the satellite, the user terminal and the gateway. The system comprises two bi-directional radio links:

- **Service link**: established between the satellite(s) and the mobile handsets (also known as User Equipment, UEs); and
- **Feeder link**: through which aggregated traffic is sent, and received, between the satellite and a gateway ground station.

2.9 The proposals in this consultation are intended to address spectrum management considerations associated only with the Service Links. Ofcom already has a licence product for Feeder Links, the Non-Geostationary Gateway licence, which is available in the uplink parts of Ku band and part of the Ka band. Separately, we plan to consult on proposals to authorise Feeder Links in Q/V and E band spectrum.[1]

Figure 1: The main components of a D2D network



2.10 Given the challenges associated with establishing a radio connection between a standard mass-market mobile handset and a satellite, we anticipate that D2D services in mobile bands will be likely to use constellations of satellites in Low Earth Orbit (LEO), rather than single satellites in Geostationary (GEO) orbits.

2.11 By operating at low altitude these satellites can deliver a stronger, more reliable mobile signal on the ground, and coverage and capacity of the network can be increased over time by adding more satellites. However, these low earth orbit constellations can create a more

[1] In March 2024, we published a Call for input on Expanding spectrum access for satellite gateways.

complex radio environment and must be carefully managed to avoid interference to other spectrum users.

2.12 The number of satellites per constellation will vary. Some D2D Satellite Operators are proposing constellations made up of fewer than 100 satellites, whilst others are developing and deploying constellations formed of hundreds of satellites for initial services, with plans to expand and deploy more over time. The coverage and capacity provided by D2D satellite networks will depend on the number of satellites, their altitude, orbital planes, and the antenna systems they use. We expect service levels to evolve and coverage, capacity, and reliability to improve as the D2D satellite constellations are expanded.

2.13 We also expect to see variations in how operators deploy the radio equipment that communicates with the handsets over the service link – known as the Radio Access Network (RAN). Some operators are deploying the RAN on the ground, with their radio signals sent to the satellite via the Feeder Links and on to the handset via the Service Links; this is known as a 'bent pipe' satellite architecture. In other architectures, the RAN base stations are mounted on the satellites.

2.14 The three potential authorisation frameworks we are consulting on are set out in section 5. We intend to be technology neutral as to the specific architecture and deployment models developed for UK D2D networks, to enable innovation and evolution of these new technologies.

A range of D2D service models may develop in the UK

2.15 D2D services are at an early stage of development globally. This means that there are a range of service offerings and business models that may emerge in the UK to provide connectivity in areas where the user of a mobile handset cannot connect to a terrestrial network.

Consumer service

2.16 The consumer experience of using D2D networks may vary by operator and evolve over time. For example, initial services may be limited to SMS text, with voice and data services introduced in the future. This service evolution may have implications for how consumers are able to contact the emergency services.

2.17 Where voice services are offered, the consumer experience may vary depending on the business model agreed between the Satellite Operator and the MNO. For example, in some models the consumer may have a seamless experience of switching between the MNO's terrestrial network and the satellite, but in other models the satellite connectivity could be offered as a distinct service, more akin to the international roaming consumers are familiar with when they travel abroad.

Retail and wholesale business models

2.18 The early trials and commercial deployment of D2D in other countries have adopted a business model in which the Satellite Operator provides a wholesale service, and the MNO provides a retail service to its end users. For example, the MNO includes access to D2D to customers on its premium tariffs or as a 'bolt on' extra. The MNO's customers would not necessarily be aware whether their service, in a given moment, is supplied by the MNO using a terrestrial radio mast, or by a satellite in space. We anticipate that this is likely to be

the model that emerges in the UK in the short term. However, our proposals are intended to be neutral as to specific business models**,** subject to our broader duties around spectrum management and competition. For example, our proposals would enable an MNO to offer wholesale access to D2D services to other MNOs and MVNOs (see section 5 for more detail).

2.19 The proposals set out in this consultation would enable D2D services to be provided by MNOs and Satellite Operators working in partnership. This reflects the evidence we received in response to our CFI, and our broader understanding of developments in the market. Should other business models develop, parties should indicate this to us, and we will consider this further.

1) Do you agree with our assessment of the business models that could potentially emerge?

a. Are there other D2D business models that you think could deliver benefits for people and businesses in the UK?

b. Are there any business models that could not operate under our proposed approaches?

International context

International Harmonisation

2.20 The International Telecommunication Union's (ITU) Radio Regulations govern international radio-frequency spectrum and the associated orbital resources. D2D services are classified as a Mobile Satellite Service (MSS)[2]; the Radio Regulations do not currently include any MSS allocations in the frequency bands (used by mobile IMT services) that we are considering making available for D2D services (see Table 3.1). Due to this, there is a requirement upon member states which allow the use of mobile frequencies for satellite D2D services to ensure that these services operate on a 'non-interference, non-protection' basis under Article 4.4 of the Radio Regulations[3]. In the context of the assignment of spectrum use on specific satellites, the relevant ITU member state is the filing administration for the satellite with associated obligations.

2.21 With several satellite companies seeking to offer D2D services and increased consumer demand worldwide for ubiquitous connectivity, there has been significant international interest in the development and authorisation of D2D services. International work has already begun with the aim to update the Radio Regulations to take account of this.

[2] Under Article 1.25 of the ITU's Radio Regulations, MSS is defined as "a radiocommunication service between mobile earth stations and one or more space stations, or between space stations used by this service."
[3] Article 4.4 sets out that "administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations, or the other provisions of the Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference cause by, a station operating in accordance with the provisions of the Constitution , the Convention and these Regulations".

At the next ITU World Radiocommunications Conference in 2027 (WRC-27), agenda item 1.13[4] will consider proposals to include new allocations for the Mobile Satellite Service in bands currently allocated to the terrestrial mobile service in the frequency range between 694/698 MHz and 2.7 GHz. The UK is actively engaged in the international working groups preparing this, including consideration of coexistence between D2D satellite services and terrestrial mobile services.

2.22 If member states agree on an approach for enabling D2D services in mobile bands, WRC-27 may decide to:

a) add MSS allocations in some mobile bands; and
b) implement a common set of technical and operational measures to ensure that the satellites and terminals (e.g. handsets) in the mobile-satellite service do not cause harmful interference to, or claim protection from, base stations and terminals operating in the terrestrial mobile service.

2.23 A lack of international harmonisation, or regulation, does not prevent individual countries from authorising D2D services within their borders (subject to meeting certain conditions). We believe that our proposals to authorise these services in the UK before WRC-27 will enable the timely realisation of benefits for UK consumers and businesses. However, we also plan to review any authorisation framework following the outcome of WRC-27.

D2D authorisation in other countries

2.24 In line with the above, we have already seen the development and implementation of national frameworks to authorise D2D services across several administrations around the world.

2.25 The FCC has implemented a national authorisation framework for D2D services, by adding a secondary MSS allocation to the US Frequency Allocation Table (USFAT) for bidirectional operations in some terrestrial mobile bands.[5] In certain bands designated for Supplemental Coverage from Space (SCS), authorisation can be obtained only where a terrestrial operator holds all licences on the relevant channel throughout a defined geographically-independent area (GIA). Additionally, a Part 25 licence[6] must be held by the satellite operator.

2.26 Some providers, including AST SpaceMobile, have been approved by the FCC for testing D2D services in the US. The FCC also granted a temporary authorisation to Starlink to provide D2D services as part of the hurricane relief effort to provide backup connectivity, in October 2024[7]. In November 2024, it granted conditional approval to Starlink and T-Mobile

[4] Resolution 253 (WRC-23) on Studies on possible allocations to the mobile-satellite service for direct connectivity between space stations and International Mobile Telecommunications (IMT) user equipment to complement terrestrial IMT network coverage.
[5] 614-652 MHz and 663-758 MHz, 775 MHz-788 MHz, and 805-806 MHz, 824-849 MHz and 869-894 MHz, 1850-1920 MHz and 1930-2000 MHz, and 2305-2320 MHz and 2345-2360 MHz (FCC 22-23).
[6] Part 25 licences authorise the operation of a satellite or satellite constellation for commercial purposes.
[7] Hurricane relief service plan - Starlink [Accessed: 19 March 2025]

to begin offering a commercial service to T-Mobile subscribers[8] in the 1910 – 1915 MHz and 1990 – 1995 MHz bands.[9]

2.27 In 2023, the Australian Communications and Media Authority (ACMA) consulted on satellite direct-to-mobile services and the regulatory issues faced in Australia. They provided an update in 2024, in which they said they would authorise these services in several bands[10] without need for further specific approval from the ACMA. They also set out regulatory guidance for these services, which predominantly rely on Article 4.4, and requires a partnership with an existing IMT licensee.

2.28 The Canadian department for Innovation, Science and Economic Development (ISED) has published its decision on a policy, licensing and technical framework to authorise D2D services in specific mobile bands[11], ahead of WRC-27. The framework will consider applications on a case-by-case basis, requiring a non-exclusive agreement between a mobile operator and a satellite operator and states that licensees must not cause interference to, and are not protected from, licensee's spectrum.

2.29 In Europe, the Radio Spectrum Policy Group (RSPG) published a consultation in February, asking the European Commission to issue a mandate to CEPT to develop harmonised technical conditions for satellite D2D services in mobile bands. The consultation also identifies three approaches to authorising D2D in mobile bands at a national level.

2.30 Elsewhere, New Zealand MNO One NZ recently launched a D2D service in partnership with Starlink, initially offering text services on selected handsets and subscriber plans.

2.31 The authorisations made by other administrations listed above have, so far, relied on a commercial partnership between a Mobile Network Operator (MNO) and a satellite operator. This approach allows satellite operators to access spectrum already licensed to MNOs and supports coordination between the satellite operator and the MNO, helping to mitigate any potential interference risks to the terrestrial mobile network.

Ofcom's Duties

2.32 Our proposals are aligned with our statutory duties and powers in relation to spectrum management which are set out primarily in the Communications Act 2003 (the "2003 Act") and the Wireless Telegraphy Act 2006 ("WTA"). We set these out in detail in Annex A1. This includes our principal duty to further the interests of citizens in relation to communication matters, and to further the interests of consumers in relevant markets, where appropriate by promoting competition. In particular, we consider that our proposals further the interests of citizens and consumers by allowing D2D services to make use of mobile

[8] T-Mobile US and SpaceX recently unveiled plans for a public beta test of their D2D service, making it available to all US consumers, including non-T-Mobile consumers. The service will be free until July 2025 – Mobile World Live [accessed 17 February 2025].

[9] SpaceX authorised for SCS and operations at lower altitudes – FCC [Accessed: 03 February 2025].

[10] In their Regulatory Guidance document, the ACMA set out that operation of D2D is only practical under an Australia-wide spectrum licence, therefore they recommended the 700 MHz, 800 MHz, 850/900 MHz and 2.5 GHz as suitable for these services.

[11] 617-652 MHz and 663-698 MHz, 698-756 MHz and 777-787 MHz, 824-849 MHz and 869-894 MHz, 1710-1755 MHz and 2110-2155 MHz, 1755-1870 MHz and 21554-2180 MHz, and 1850-1915 MHz and 1930-1995 MHz.

spectrum earlier, delivering benefits for consumers and citizens (as set out above, and in Annex A2) sooner than would otherwise be the case.

2.33 We consider these proposals would promote the efficient use of spectrum by enabling satellite-sharing of mobile spectrum, thus giving MNOs and Satellite Operators the opportunity to provide a greater variety of services from the same spectrum holding.

2.34 We must also have regard to the UK Government's Statement of Strategic Priorities (SSP) when exercising our functions relating to the management of radio spectrum and postal services.

2.35 Our view is that our proposals are consistent with the SSP by enabling MNOs and Satellite Operators to provide a service that has the potential to extend outdoor mobile coverage to 100% of the UK landmass; to provide a basic level (at least in the short term) of connectivity in areas currently not served; and to address 'not-spots'. Our proposals would also support increased sharing in the mobile bands, increasing the utilisation of the spectrum.

2.36 In exercising certain regulatory functions, we must have regard to the desirability of promoting economic growth.[12] In formulating our proposals, we also had regard to our "growth duty", a statutory obligation to have regard to the desirability of promoting economic growth, and to the statutory guidance that accompanies that growth duty. We do so in the context of our primary duty to further the interests of citizens and consumers, where appropriate by promoting competition, and having regard, amongst other things to encouraging investment and innovation.

2.37 We consider that our proposals will support growth in the UK by enabling an innovative new service to be offered to UK consumers and businesses, through a flexible authorisation framework ahead of WRC-27, making it easier for operators to rollout mobile coverage to areas not reached by current and planned terrestrial infrastructure. Separately, our proposals are neutral to the D2D technology and architecture deployed, thereby encouraging innovation and competition between potential D2D providers.

Structure of this document

2.38 The structure of this document is as follows:

- **Section 3** outlines why we are proposing to authorise D2D services in the UK and summarises our proposals;
- **Section 4** provides detail of our coexistence analysis;
- **Section 5** discusses our approach to authorising D2D services in the UK;
- **Section 6** discusses our proposed conditions for authorisation; and
- **Section 7** sets out our next steps for authorising D2D services in the UK following this consultation process.

2.39 The consultation also includes the following annexes:

i) Legal framework

[12] Section, 108 Deregulation Act 2015. Section 111 defines 'regulatory function'. The Economic Growth (Regulatory Functions) (Amendment) Order 2024 applies the duty set out in section 108 to Ofcom.

ii) Impact Assessments
iii) Calculation of PFD limits for coexistence with mobile services
iv) Coexistence Risk Assessment
v) Overview of Local Access and Offshore Network licence deployments, including map of locations
vi) Responding to this consultation
vii) Ofcom's consultation principles
viii) Consultation coversheet
ix) Consultation questions

3. Enabling D2D in the UK

3.1 In this section we explain why we are proposing to enable D2D in the UK now and provide a high-level overview of our approach and how this approach aligns with our duties. We provide further details in subsequent sections and annexes.

D2D can benefit people and businesses in the UK

3.2 Based on our engagement with industry stakeholders and responses to our July 2024 CFI, we consider that D2D networks can deliver benefits to people and business in the UK, and that there are operators interested in offering a D2D service in the near future.

3.3 We consider that an authorisation for D2D services is necessary to manage the risks that the introduction of D2D services in mobile spectrum could cause harmful radio interference to existing radio spectrum users. We are consulting on our proposals now because we wish to enable the potential benefits for people and businesses in the UK as soon as possible, and support innovation, growth, and investment in this area.

3.4 We think there are several potential benefits of enabling D2D services, including:

a) extending voice, messaging, and data coverage beyond the reach of terrestrial networks, potentially enabling ubiquitous, outdoor coverage across 100% of the UK landmass as constellations roll out and technology matures;
b) providing a degree of backup coverage during power outages or network faults which affect terrestrial base stations, such as natural disasters or extreme weather events, enhancing the resilience of mobile networks; and
c) improving access to emergency '999' services as a result of the above.

3.5 We expect that D2D would play a role in providing supplementary coverage for existing terrestrial networks, rather than providing a substitute for existing terrestrial mobile masts.

3.6 Stakeholder responses to the CFI were in broad agreement on these benefits, with the extension of emergency '999' service access identified as a key benefit of enabling D2D in the UK. We discuss the potential for provision of '999' services via D2D in more detail in paragraphs 3.10-3.13.

3.7 With 95% of the UK landmass currently served by at least one MNO's 4G network[13], the potential benefit of D2D to UK consumers, businesses, and the public sector may be more limited in comparison to countries that have less geographic coverage from their terrestrial networks. For example, countries with large areas of low population density - such as Australia, the US, and Canada - often have poor or no coverage in these areas. Separately, widespread benefits of D2D may not be realised immediately upon the launch of commercial services and initial services may be limited in coverage, capacity, and capabilities.

3.8 Nonetheless, we believe that the UK could benefit from the rollout of D2D services and consider that our proposals will promote the interests of UK consumers, particularly those

[13] Connected Nations Report, Ofcom, 2024.

living in or visiting rural areas and using our coastal waters. Separately, these proposals can support efficient use of spectrum, whilst encouraging investment and innovation and supporting growth.

3.9 The proposals outlined in this document support Ofcom's core mission to make communications work for everyone and support our statutory duties as the UK's communications regulator. We set out more detail in our Impact Assessment in Annex 2.

2) Do you agree with our assessment of the benefits that could be realised through authorisation of D2D services?

a. Are there any other benefits for UK citizens and businesses that could be realised?

999 Calling

3.10 Given that the extension of emergency services access – and the ability to contact the emergency services anywhere in the UK – is likely to be a key benefit of the introduction of D2D services, we are keen to see this benefit extended to as many mobile users in the UK as possible.

3.11 Ofcom's General Conditions of Entitlement ("General Conditions") are the regulatory conditions that all providers of electronic communications networks and services must comply with if they want to provide services in the UK. [14] General Condition A3 aims to ensure the fullest possible availability of public communications services at all times, including in the event of a disaster or catastrophic network failure, and uninterrupted access to emergency organisations. It requires providers of call services to ensure that calls can be made to emergency organisations free of charge and to make caller location information available to emergency organisations where technically feasible. Services provided by satellites will be captured by the General Conditions where the services provided meet the criteria set out in each individual condition. In relation to contacting the emergency services, a D2D service that includes the ability to make voice calls, as defined by the General Conditions, will be required to comply with General Condition A3 relating to the availability of services and access to emergency services[15].

3.12 In existing terrestrial mobile networks, the MNOs collaborate to support 'Emergency Call Roaming'[16]. This arrangement allows customers of an MNO to make an emergency call on a different MNO network when they are outside of coverage of their home mobile network.

3.13 We recognise the potential for D2D services to extend emergency services access across the UK, and we will undertake bilateral engagement on this theme with MNOs and prospective

[14] See sections 45 to 48 of the Communications Act 2003.

[15] General Condition A3.2(b) states that "Regulated Providers must take all necessary measures to ensure uninterrupted access to Emergency Organisations as part of any Voice Communications Services offered." Voice Communications Services is defined as "a service made available to the public for originating and receiving, directly or indirectly, national or national and international calls through a number or numbers in a national or international telephone numbering plan". For more information see the unofficial consolidated version of the current General Conditions, which came into force on 1 February 2025.

[16] When a mobile network is 'down', or a person doesn't have coverage from their home mobile network, a handset should be able to roam to another network to make emergency calls. The handset must be in coverage of at least one terrestrial network for this to work.

D2D satellite providers, covering both their own customers and other mobile users in the UK, and how this capability might evolve over time. Please refer to the Impact Assessment in Annex 2 for more detail.

3) Do you have any comments on how emerging D2D technology should support 999 service provision?

We propose authorising D2D in a subset of existing mobile bands

3.14 In developing our proposals, we have considered three key elements:

a) which spectrum bands to allow to be used for D2D;
b) what the geographic territory of the service should be; and
c) how to ensure that the D2D satellite operator and the MNO work together so that the service delivers benefits for end users and does not cause harmful interference to existing spectrum users, in such a way that enables us to meet our spectrum management duties.

3.15 We address each of these points below and provide more detail in subsequent sections.

Spectrum bands

3.16 To facilitate the benefits of D2D, at this stage we are proposing to authorise D2D in a subset of existing mobile frequencies below 3 GHz in FDD or SDL bands, as set out in Table 3.1.

3.17 All mobile spectrum bands in Table 3.1 have been licensed on a nationwide basis, making them suitable for provision of D2D services across the UK. Details of the specific spectrum holding for each MNO can be found on our website.

Table 3.1: Proposed D2D bands in mobile spectrum licensed to UK MNOs[17]

	Frequency range		
	UE Tx / BS Rx	BS Tx / UE Rx	Duplex Mode
700 MHz	703 – 733 MHz	758 – 788 MHz	FDD
		738 – 758 MHz	SDL
800 MHz	832 – 862 MHz	791 – 821 MHz	FDD
900 MHz	880.1 – 914.9 MHz	925.1 – 959.9 MHz	FDD
1400 MHz		1452 – 1492 MHz	SDL
1800 MHz	1710.1 -1785 MHz	1805.1 – 1880 MHz	FDD

[17] Mobile spectrum bands can be categorised as either Frequency Division Duplexed (FDD), Time Division Duplexed (TDD) or Supplementary Downlink (SDL). Mobile base stations (BS) and handsets (User Equipment, UE) deployed in FDD bands use different frequency ranges for transmission (Tx) and reception (Rx), whereas in TDD bands transmission and reception use the same frequencies. SDL bands are typically used to add additional downlink capacity to an FDD band. There are no FDD bands above 3 GHz in the UK.

	Frequency range		
2.1 GHz	1920 – 1979.7 MHz	2110.3 – 2169.7 MHz	FDD
2.6 GHz	2500 – 2570 MHz	2620 – 2690 MHz	FDD

3.18 At this point we are not proposing to consider requests for operation in TDD bands.[18] We understand that building D2D networks that operate in TDD bands is more complex; further there is an increased risk of interference to adjacent channel mobile systems due to the need to accurately time synchronise the networks. Additionally, we are not aware of demand to use TDD mobile spectrum for D2D in the short term.

3.19 We are proposing to consider requests for SDL bands. Unlike TDD bands, deployment of SDL spectrum is unlikely to require complex time synchronisation. We are interested in stakeholder views on whether use of SDL spectrum in conjunction with other FDD bands raises any specific technical challenges, and whether there is any demand to use this spectrum for D2D in the UK.

3.20 It appears to Ofcom to be likely that, in the first instance, any D2D deployment will only utilise a subset of frequencies within the partnered MNO spectrum holdings, for example, 2x5 MHz block of spectrum within a given band.

4) Are there any mobile spectrum bands not in scope of our proposals that you think we should consider?

5) Does deployment in supplementary downlink spectrum (SDL) present any challenges in comparison to other bands? Is there interest in deploying in this spectrum?

Services would be enabled for the UK mainland and territorial seas

3.21 We propose that any authorisation would be limited in geographic scope to the UK mainland and territorial seas.[19] This authorisation would not enable operation on the Channel Islands or Isle of Man at this stage. Should operators wish to deploy in these territories, they would have to obtain agreement from the relevant island authorities.

3.22 We are not currently proposing to enable D2D on offshore platforms as they sit outside of the UK territory and the MNO spectrum existing spectrum licences do not authorise them to provide a terrestrial mobile service in these locations. Enabling services beyond the UK's territorial waters could also increase the risk of cross-border interference as the satellite transmissions would be closer to the borders of neighbouring countries.

[18] 1900 – 1920 MHz, 2350 – 2390 MHz, and 2570 – 2620 MHz. All the bands licenced to MNOs above 3 GHz are also TDD.

[19] Up to 12 nautical miles (13.80 miles) from the coastline, or the mid-point between the UK and a neighbouring administration.

6) Do you agree with our proposal to limit this authorisation to the UK mainland and territorial waters? If not, please explain why.

Satellite Operators and MNOs will need to partner to provide D2D services

3.23 We expect that Satellite Operators and MNOs will have to collaborate closely to provide D2D services to UK citizens and businesses and avoid interference between the terrestrial and satellite components of the combined network. This will involve careful coordination of frequencies used and the geographic separation of the terrestrial coverage and the satellite coverage in situations where they use exactly the same frequencies. Collaboration will also be required to avoid causing undue interference to other spectrum users in the UK and cross-border in line with the proposed technical conditions set out in section 4.

3.24 We go into more detail on our proposals, setting out different options for an authorisation framework, in section 5.

4. Managing spectrum interference

4.1 D2D services have the potential to cause harmful interference to other spectrum users. This section outlines the key coexistence factors we need to consider when authorising a D2D service and sets out our technical analysis and proposed technical conditions necessary to manage the risk of harmful interference to other spectrum users.

D2D will need to coexist with existing spectrum users

4.2 Whenever a new spectrum user is introduced, we need to consider several factors:

a) the risk of interference to existing users;
b) what conditions need to be implemented by the new entrant to mitigate the risk of interference; and
c) what action must be taken if the mitigations are not effective.

4.3 Authorising spectrum use enables us to reduce the risk of interference and have the ability to address it if it occurs. Before developing our authorisation approach, it is necessary to understand the nature of the interference risk posed by the introduction of D2D.

4.4 Interference risks from D2D networks fall within two broad categories. The first is "out of area" interference in which the signal from the satellite hits the ground outside of the D2D service area.[20] This includes the risk of interference to mobile networks in neighbouring countries. The other is "unwanted emissions" in which the satellite transmits in frequencies other than those listed in its authorisation. This is sometimes called "out of band" interference. Whilst out of area and unwanted emissions are a feature of most radio systems, the associated signal strengths need to be kept below certain limits to prevent undue interference to other spectrum users.

4.5 There is also a risk of interference into the MNOs terrestrial network from their partnering Satellite Operators transmitting into the same location in the UK on the same frequencies. For reasons set out below, we think this risk of 'intra D2D network' interference will be managed most effectively by the MNO and Satellite Operator working together.

4.6 The nature of any potential undue interference caused by D2D networks could vary depending on the system architecture and deployment. Typically, each satellite will transmit multiple beams on the ground, and where these beams overlap, they combine to create an aggregate, stronger signal that could result in a higher risk of interference to other services, in comparison to individual beams. We expect that Satellite Operators will

[20] Where "D2D service area" means the area where a D2D service is intended to be provided, which will be a subset of the authorised service area. It excludes areas with Local Access Licences or Offshore Network Licences. We use the term "authorised service area" to refer to the area in the UK in which we have authorised a D2D service. The authorised service area may carry coordination requirements so D2D providers may not be able to provide a D2D service across the entire authorised service area.

have the ability to adjust the power, shape, and direction of beams to reduce the risk of aggregate interference both out of area and for unwanted emissions.

We are proposing technical conditions to manage the risk of D2D causing undue interference

4.7 In this section we consider coexistence between D2D and incumbent spectrum users, as shown in Table 4.1 below. In order to minimise the risk of undue interference to other mobile networks caused by out of area and unwanted emissions, we are proposing technical conditions on D2D satellite transmissions. We have also produced a band-by-band coexistence assessment, setting out which mobile bands may be more challenging to achieve coexistence with other users in adjacent spectrum and where additional coexistence mitigations may be required.

4.8 We have not assessed the potential for interference from D2D satellite transmissions into other space receivers. We consider that this a matter for the satellite filing administration[21] to take into account as part of its processing of the filing.

4.9 We may need to consult further on technical conditions for coexistence, including in relation to the specifics of an individual licence application or licence exemption, depending on which authorisation option is pursued (see section 5). We may be able to authorise D2D more quickly in mobile bands where we have indicated that the coexistence risk is lower because fewer coexistence assessments are likely to be necessary and fewer mitigation remedies may need to be developed.

Table 4.1: Coexistence scenarios between D2D and incumbent spectrum users

	In the UK	Outside of UK
Co-channel	Local and offshore mobile networks	Cross-border mobile networks
Adjacent spectrum	UK mobile networks and other spectrum users	N/A[22]

[21] A satellite filing administration is an administration that acts on behalf of organisations and companies to submit 'satellite filings'. These are tools to obtain – through the ITU – international recognition of satellite resources.

[22] We have not studied this coexistence scenario in more detail. We believe that the unwanted emissions from D2D satellite transmissions in areas outside of the UK are likely to be very low. This is because Satellite Operators will need to ensure that their co-channel emissions do not cause interference to mobile networks in other countries and unwanted emissions will be lower than co-channel emissions.

Coexistence with terrestrial mobile services

Co-channel interference in the UK will be managed by the satellite operator and its partner MNO

4.10 Whilst there is a risk of 'self-interference' between the partnering MNO's terrestrial network and the Satellite Operator's satellite transmission, we expect that coexistence between the terrestrial and satellite components of the combined network will be managed by a coordination arrangement between the MNO and the D2D operator. We do not believe that an MNO and its partnering D2D satellite operator can transmit in the same location, using the same spectrum without the risk of interference between the terrestrial and satellite components of the service. However, given that their incentives to coordinate should be aligned, we have not studied this scenario further in our analysis.

The risk of interference from mobile terminals will not change

4.11 We expect terminals (i.e. handsets) that connect to D2D services will be unmodified and comply with the same transmission power levels and other technical requirements as those permitted under the current licence exemptions (and we propose to make this a condition of any authorisation). We therefore consider that transmissions from terminals as part of a D2D service will not pose any additional risk of interference and so we have not studied the risk of interference from terminal transmissions further in our coexistence analysis.

Technical conditions on D2D satellite transmissions are needed to prevent interference to the mobile services of other operators

4.12 The main risk of interference associated with the introduction of D2D services relates to the transmissions from the satellite into existing mobile handsets and mobile base stations of other MNO networks.

4.13 Our analysis indicates that power limits on D2D satellite transmissions in mobile downlink spectrum are necessary to prevent undue interference into mobile handset receivers of customers of other operators. We also believe that a minimum elevation angle limit on D2D satellite transmissions is necessary to prevent undue interference to mobile base stations of other operators. The mobile bands identified for D2D are typically used to provide services to consumers nationwide in the UK and so there is a significant risk of interference without mitigation.

4.14 As a method of managing the risk of interference from D2D satellite transmissions, we have considered relying on our standard licence conditions which require authorised parties to cease transmitting if they are causing interference – that is, taking an approach in which we do not stipulate specific technical conditions. We do not believe that this would provide sufficient regulatory certainty to allow us to achieve both our goals of (i) enabling new D2D services to operate in the UK; and (ii) ensuring coexistence with terrestrial mobile services.

4.15 We have therefore developed proposed technical conditions which would apply on all out of area and unwanted emissions from D2D satellite transmissions. We consider that the

mobile coexistence scenarios in the UK, listed above in Table 4.1, are all sufficiently similar that the same technical conditions on D2D satellite transmissions would be sufficient to ensure coexistence in all the mobile coexistence scenarios in the UK.

4.16 These technical conditions may not be sufficient to ensure coexistence with all users of adjacent spectrum and we consider which frequency bands might require additional coexistence mitigations in *Coexistence with other adjacent band spectrum users* below.

Our proposed technical conditions for coexistence with terrestrial mobile services of other operators

4.17 We are proposing specific technical conditions for D2D services with the aim of ensuring coexistence between new D2D satellite transmissions and terrestrial mobile services.

4.18 Our proposed power limits as shown in table 4.2 below are aggregate PFD limits, i.e. the D2D provider would need to ensure that the total emissions from all of their satellites do not exceed the limits at any location on the surface of the Earth where the limit applies.

4.19 Our proposed minimum elevation angle for D2D satellite transmissions as shown in table 4.3 below applies at all locations within the D2D service area.[Error! Bookmark not defined.] D2D providers would need to ensure that they are not providing a D2D service to areas at lower elevation angles.

4.20 We will likely amend these conditions, as part of a review of the framework, once we know the outcome of WRC-27, at which time we will have more evidence about the risk of interference from D2D satellite transmissions to terrestrial mobile services. However, in the interim we consider that these proposed limits are a proportionate means to manage the risk of undue interference from D2D services.

Table 4.2: Proposed power limits for D2D satellite unwanted emissions and out of area emissions in mobile downlink spectrum. These power limits would apply at the surface of the earth

Mobile Band	PFD Limit in mobile downlink spectrum
MHz	*dBW / MHz / m^2*
700, 800, 900	-119
1400	-113
1800, 2100	-111
2600	-108

Table 4.3: Proposed minimum elevation angle for D2D satellite emissions. This limit would apply to each point at the surface of the earth in the D2D service area relative to the satellite providing the best serving beam at each pixel

Mobile Band	Minimum elevation angle of transmission
MHz	*degrees*
All	20

We carried out technical analysis to inform our proposed technical conditions

4.21 We analysed coexistence between D2D satellite transmissions and mobile user equipment and mobile base stations in order to define our proposed technical conditions.[23] This analysis is an extension of the work done as part of the WRC-23 preparations to define PFD limits for high altitude platforms as base stations ("HIBS") for ensuring coexistence with terrestrial mobile services. We consider that extending this analysis to define PFD limits for D2D satellite transmissions is appropriate because we consider that the scenario geometry is similar. We observe that the work currently in progress as part of AI 1.13 for WRC-27 uses the WRC-23 HIBS analysis as its starting point.

Power limits for coexistence with mobile terminals

4.22 We grouped frequency bands where the spread in the PFD limit, we calculated was 2 dB or less. We believe that this strikes an appropriate balance between simplifying our limits while keeping them suitable for all frequency bands. We have selected the lowest PFD limit in each group of frequency bands because we believe that this will protect all the mobile terminals in each group of frequency bands.

4.23 We have converted our PFD limits to Reference Signal Received Power ("RSRP") which is a commonly used metric for assessing received signal strength in mobile networks.[24] For all mobile bands, the equivalent RSRP limit was -126 dBm[25] which we note is 6 dB below the minimum useable sensitivity of terminals, -120 dBm. We are therefore confident that the proposed PFD limits would protect terminals in noise-limited environments including the edge of coverage in rural areas.

Minimum elevation limit for coexistence with mobile base stations

4.24 We believe that a minimum elevation limit is appropriate for managing the risk of interference from D2D satellite emissions to mobile base stations of other operators. This is because our analysis has shown that rural macrocell base stations are more sensitive than mobile terminals by 21 dB when the satellite is at the horizon and 8 dB more sensitive when

[23] Annex A3
[24] Ibid. See heading: "Equivalent RSRP"
[25] RSRP, unlike PFD, does not have a frequency dependency which is why we can calculate a single value for all mobile bands.

the satellite is at an elevation angle of 20 degrees.[26] This is because mobile base stations typically have greater antenna discrimination towards the sky than they do towards the horizon.

4.25 Mobile uplink spectrum in FDD bands is at a greater frequency separation from D2D satellite transmissions than users in adjacent mobile downlink spectrum and we believe that this additional frequency separation would provide sufficient additional isolation such that unwanted emissions from an elevation angle of 20 degrees and higher would not risk causing interference to mobile base stations. However, we cannot be certain that this frequency separation will guarantee that unwanted emissions will have fallen to a sufficiently low level to protect base stations when the satellite is at an elevation angle of below 20 degrees. We therefore believe that a minimum elevation limit is a proportionate technical condition to ensure coexistence.

Our proposed power limits are for aggregate D2D satellite emissions

Aggregation

4.26 Our proposed power limits are maximum aggregate power limits. We considered a "per satellite" transmission limit; however, we believe that this would not be appropriate. This is because Satellite Operators are proposing to build satellite constellations with very different deployment densities and so any "per satellite" limit may not be appropriate for all satellite constellations because the impact of aggregation emissions would be different for each D2D constellation. It might be easier to set an aggregation factor, and therefore calculate "per satellite" limits, in the future when we will have more information about mature D2D constellations and information about whether they have similar constellation densities.

Apportionment

4.27 We have considered applying an apportionment factor to account for multiple D2D providers operating in a band. This is because multiple D2D providers in the same band could exceed the limit necessary to protect mobile services if the limit was not apportioned between them. An apportionment factor is a fair way to share the aggregate interference limit between operators who may have very different satellite constellation densities and beam management strategies.

4.28 We propose not to divide the D2D satellite transmission limit in each mobile band among different D2D providers. D2D is a relatively new technology, and it is uncertain how many D2D providers will operate in each mobile band as the market matures. However, we are proposing a condition of authorisation which enables us to apply an apportionment factor (if necessary) when assessing an authorisation request, should it become evident that multiple D2D providers aim to offer D2D services in the same mobile band.

[26] See Table A3.4. Our analysis assumes that a rural microcell base station has a downtilt of 3°. Suburban and urban base stations typically have greater downtilt than rural macrocells and so will be less sensitive to potential interference from D2D transmissions.

D2D providers will need to ensure that they do not cause interference to mobile networks in other countries

4.29 MNOs must comply with conditions set out in Memoranda of Understanding (MoU) Ofcom has with neighbouring countries and crown dependencies.[27] These MoU set out cross-border power thresholds for terrestrial mobile networks which, if exceeded, require MNOs to enter into coordination arrangements. These MoU do not contain cross-border power thresholds for D2D satellite emissions, and we do not expect any cross-border conditions to be developed until after WRC-27. As described above in *International Harmonisation* in Section 2, D2D satellites operate on a 'non-interference, non-protection' basis under Article 4.4 of the Radio Regulations (this may change after WRC-27).

4.30 Our analysis shows that our proposed emissions limits for D2D transmissions in mobile downlink spectrum are more conservative than existing cross-border coordination trigger thresholds for all but one band.[28] The exception is the cross-border threshold for 2100 MHz with the Republic of Ireland, the Isle of Man and France.

4.31 In the case of 2100 MHz, we found that the power limit calculated by our analysis was 6 dB more relaxed than the threshold in our cross-border MoU with the Republic of Ireland, the Isle of Man and France.[29] This is because the existing MoU cross-border coordination trigger threshold with these countries in 2100 MHz is relatively restrictive, for example, it is 10 dB more restrictive than the equivalent threshold for 1800 MHz.[30]

4.32 We believe that our analysis shows that the technical conditions that we have proposed should be sufficient for protecting cross-border mobile use in all mobile bands, although we note that some further consideration of 2100 MHz may be necessary. Further, we would expect any future D2D providers to engage with neighbouring administrations and ensure their transmissions do not cause cross-border interference.

Coexistence with other adjacent band spectrum users

We believe that D2D satellite transmissions in 1400 MHz and 2600 MHz may require additional technical conditions

4.33 We have considered the coexistence of new D2D satellite services with the diverse set of incumbent users in adjacent spectrum for our initial coexistence assessment. Our analysis is high-level, as a detailed assessment with every incumbent user is unnecessary for bands that are not of interest to D2D providers. We would consider whether a further detailed coexistence assessment was necessary once we identify which mobile band(s) are most

[27] International coordination, Last updated: 29 November 2024

[28] We have considered the non-preferential Physical-layer Cell Identity (PCI) code coordination trigger thresholds in our analysis because PCI coordination trigger thresholds were developed for terrestrial mobile networks and so may not be appropriate for D2D satellite transmissions arriving from a high elevation angle. We discuss this in more detail in *Comparison with cross-border coordination limits,* Annex 3.

[29] See Table A3.5

[30] Table 6, Memorandum of understanding on frequency coordination between the Republic of Ireland and the United Kingdom of Great Britain and Northern Ireland concerning the spectrum coordination of mobile/fixed communications networks in the frequency range 703 MHz to 43.5 GHz, ComReg and Ofcom, 1 November 2024

interesting to prospective D2D providers, based on responses to this consultation or requests for a D2D authorisation.

4.34 We have used the UK FAT[31] and spectrum map[32] to identify incumbent services in spectrum adjacent to mobile bands. We have considered primary services operating in spectrum within 50 MHz of the spectrum proposed for D2D satellite transmissions in mobile downlink bands (see Table 3.1). We consider that services at greater than 50 MHz frequency separation will be in the spurious domain of the D2D satellite transmissions and therefore at a very low risk of interference. The spurious domain is defined as starting at a frequency separation of more than 2.5 times the necessary bandwidth from the centre frequency of a transmission[33] and by considering services at up to 50 MHz frequency separation from the mobile band edge, we are accounting for D2D satellite transmissions of up to 25 MHz bandwidth. We consider that this is a conservative approach because we expect that D2D satellite transmissions might initially use a bandwidth of 5 MHz.[34] We consider that this conservative approach is appropriate because there is uncertainty about the unwanted emissions of D2D satellite transmissions and future D2D satellite transmissions may use a bandwidth of greater than 5 MHz.

4.35 We have assigned a risk score to each service, considering whether the service is at the same level of interference risk as the mobile service or at a greater risk of interference. This is because we have already considered the technical conditions necessary to protect mobile services (see *Our proposed technical conditions for coexistence with terrestrial mobile services* above). D2D providers might need to comply with additional technical conditions (which could include coordination requirements) to enable coexistence with services that are more likely to be affected by interference from D2D satellite transmissions than mobile services.

4.36 In determining whether a system might be at greater risk of interference from new D2D satellite transmissions than the mobile service, we took the following factors into account:

a) whether a system is likely to be more sensitive than mobile, considering noise figure, antenna gain and whether antennas tend to be pointing towards the sky;
b) the frequency separation of the incumbent service from the D2D satellite transmissions, considering that coexistence is likely to be improved at larger frequency separations; and
c) whether a system is operated indoor-only and therefore could be shielded from D2D satellite transmissions.

4.37 We also considered whether a system was locally assigned and so might be protected by being outside of a D2D service area or was nationwide and so spatial separation could not mitigate the risk of interference.

4.38 In our coexistence assessment:

[31] https://static.ofcom.org.uk/static/spectrum/fat.html
[32] https://static.ofcom.org.uk/static/spectrum/map.html#
[33] Recommends 1, ERC Recommendation 74-01, May 2022
[34] "Responses from Satellite Operators set out that the required minimum bandwidth to provide these services would be 2 x 5 MHz channels." Paragraph 2.12, Improving mobile connectivity from the sky and space: Summary of responses and next steps, 20 November 2024

a) Green means that the risk of interference is no greater than the risk of interference to a mobile receiver operating in this band. We anticipate that the amount of analysis necessary to confirm coexistence is possible is likely to be low.
b) Amber means that the risk of interference is likely to be greater than the risk of interference to a mobile receiver operating in this band. We anticipate that further analysis would be necessary to establish appropriate additional technical conditions to enable coexistence, should there be commercial interest in using these bands for D2D services.

Table 4.4: Band-by-band coexistence assessment between D2D satellite transmissions and incumbent services in spectrum adjacent to mobile bands

Mobile Band	Coexistence Assessment	Considerations with the most impact on our assessment
700	Green	PMSE and DTT operate at a large frequency separation from potential new D2D satellite transmissions (in the spurious domain), and we do not consider that they are more sensitive to interference than mobile.
800	Green	We believe that there are no services which are more sensitive than mobile in adjacent bands.
900	Green	Civil and military aeronautical systems operate above 960 MHz but we believe that they are not more sensitive to interference than mobile.
1400	Amber	MOD has some systems in the immediately adjacent spectrum which have high gain antennas that can point towards the sky. The radioastronomy service operates in immediately adjacent spectrum at six locations.
1800	Green	We believe that there are no services which are more sensitive than mobile in adjacent bands.
2100	Green	Many incumbent users already coexist adjacent to the MSS downlink in 2170-2200 MHz which suggests that there would be minimal additional risk from new D2D satellite transmissions in the 2100 MHz mobile band.
2600	Amber	Civil and military aeronautical radars operate above 2.7 GHz and terrestrial mobile networks must coordinate with 77 radar locations across the UK.[35] We do not allow transmissions from unmanned aircraft systems ("UAS") in 2.6 GHz to protect

[35] Coordination procedure for air traffic control radar - notice issued to 2.6 GHz Licensees, Ofcom, 27 September 2023; and
Protected Radar list, Ofcom, 2 August 2024

aeronautical radar[36] and further analysis would be necessary to understand the risk from D2D satellite transmissions.

The radioastronomy service operates in immediately adjacent spectrum at six locations.

4.39 Further details of our initial risk assessment can be found in Annex A4.

7) Do you agree that our proposed technical conditions for D2D satellite emissions will protect mobile services delivered by other operators in adjacent areas and in adjacent spectrum?

8) Do you agree with our high-level coexistence assessment for other services in adjacent spectrum to D2D?

9) Are there other services co-channel, or in adjacent spectrum, that you think we should take into account when assessing coexistence? If so, please provide evidence of the nature of interference and what level of protection you consider is necessary.

[36] Paragraph 1.7, STATEMENT: Spectrum for Unmanned Aircraft Systems (UAS), Ofcom, 16 December 2022

5. Our proposed approach to authorisation

5.1 In this section we (i) set out the legal analysis which informs Ofcom's current thinking in relation to our proposals on how best to authorise D2D services in the UK; and (ii) seek views on three different potential authorisation approaches we have identified:

a) **Option one:** A discretionary licence exemption for mobile handsets that connect to D2D services that comply with conditions, which would be specified in a schedule to the exemption.
b) **Option two**: A discretionary licence exemption for mobile handsets that connect to D2D services provided by an MNO whose wireless telegraphy licence has been varied to include coordination clauses for the provision of D2D services.
c) **Option three:** A user terminal licence for use of mobile handsets which would connect and transmit directly to the satellite component of the D2D system, jointly held by the MNO and the Satellite Operator.

5.2 We consider that all three options are:

a) **Objectively justified:** an authorisation is required to protect other co-channel and adjacent spectrum users from potential harmful interference caused by the D2D network, and as such are aligned with Ofcom's duties, and
b) **Non-discriminatory:** we consider that each of the options would not discriminate against users, because deploying a service is voluntary for MNOs and their partnered Satellite Operator. We also consider that each of our options would ensure that other spectrum users are protected from harmful interference, that there are low risks to competition[37], and overall, we believe that there are net benefits from our proposals.

5.3 At present, our preferred option is option two. We are seeking stakeholder inputs on all three options to inform our decision.

Legal context

5.4 As set out above, Ofcom wishes to enable new technologies and services which benefit consumers. Satellite sharing of mobile bands could lead to the provision of mobile service in cases of terrestrial network outage, and in places in the United Kingdom which, due to their geographical location or topography, do not always receive a mobile signal at present.

5.5 There are two main components of a D2D network; the system comprises service and feeder links. In this document we are concerned with spectrum management considerations associated with the service link only, as the feeder link would be authorised through our existing gateway licence authorisation framework (see section 2 for more details).

[37] See our Impact Assessments in Annex 2 for more detail.

5.6 Radio frequency use is managed by Ofcom under powers in the Wireless Telegraphy Act 2006.[38] The licensing regime is intended to separate radio spectrum users by geographical area, time or frequency range, in order to avoid harmful radio interference disrupting or destroying the successful transmission and reception of radio signals. Under the current regulatory framework[39] Ofcom does not issue radio licences for radio transmissions from satellites in space.[40]

5.7 Ofcom does however regulate radio equipment use at ground level in the UK. In some existing wireless telegraphy licences, we authorise ground terminals for use as part of satellite systems; in order to ensure efficient use of radio frequencies Ofcom requires that the network as a whole (including transmissions from the satellite) conform to certain standards.[41]

5.8 Therefore, we have considered how our existing legal powers can enable Ofcom to require companies and licensees to manage the radio signals which emanate from satellites with those emanating from mobile base stations (and other spectrum users) on the ground in order to deliver D2D services, to comply with our proposed technical conditions.

5.9 We have considered the authorisation tools available to us which could enable us to manage potentially harmful radio interference caused by D2D services in accordance with our duties under the WTA and the 2003 Act.

The ground-based equipment

5.10 The mobile network itself uses base stations to communicate wirelessly with user terminals (mobile handsets). The mobile network base stations are already authorised to do this by virtue of existing wireless telegraphy licences.

5.11 The user terminals (mobile handsets) which will connect directly to the satellite component of the D2D system to receive connectivity are also ground based. Mobile handset use is already exempt from licensing under the Wireless Telegraphy (Licence Exemption) Regulations 2003 (as amended), when sending and receiving radio signals to the mobile network base stations. Handset use is also exempt when handsets are being used on Wi-Fi or Bluetooth settings.[42]

[38] These proposals are made under the Wireless Telegraphy Act. Under the Act, it is a criminal offence to transmit into the UK's spectrum bands without a wireless telegraphy licence or an exemption.
[39] The Wireless Telegraphy Act 2006 ("WTA").
[40] s119(1)(a) WTA.
[41] We followed a similar approach with respect to the Earth Station Network (ESN) licence, which authorises the use of permanent, transportable or mobile sending and receiving network earth station(s) for the purpose of providing wireless telegraphy links between the station(s) and geostationary or non-geostationary satellite(s) (NGSO). Our associated guidance states that an "NGSO Network licence should be held by someone who has control over the whole satellite network (including associated user terminals and gateway earth stations)". The includes that the licensee must have the ability to negotiate and agree coexistence arrangement with other licence holders, in order to comply with the conditions of the licence.
[42] The Wireless Telegraphy (Exemption) (Amendment) Regulations 2023. See paragraph 4(3) in relation to IR 2030.

5.12 However, for D2D services, handsets will also send and receive signals to the satellite. This ground-based ("terrestrial" in engineering terms) use is not covered by existing exemptions and requires authorisation under the Wireless Telegraphy Act.

5.13 This consultation therefore considers the authorisation of handsets when sending and receiving radio signals to the satellite on mobile frequencies (which have been coordinated with the MNO concerned). We have set out our current thinking, including our legal analysis, and would welcome feedback from stakeholders on all aspects of it.

Key spectrum management issues

5.14 For D2D services, we are concerned about:

a) The risk of undue (harmful) radio interference which these satellite services might cause to other existing operators' terrestrial mobile networks in the UK and in neighbouring countries that are using the same frequencies;
b) The risk of interference to other mobile networks in the UK operating in adjacent spectrum blocks, and to other adjacent channel radio spectrum users in the UK and neighbouring countries[43]; and
c) D2D services potentially inhibiting the development of effective arrangements for the 'intra D2D network' sharing of frequences between the MNO and Satellite Operators themselves if transmissions from the satellite are not controlled in such a way that maximises efficient use of spectrum.[44]

Authorisation options

We have considered whether to exempt mobile handsets for D2D services

5.15 Under the WTA, unless subject to an exemption[45], it is unlawful to establish or use a wireless telegraphy station or to install or use wireless telegraphy apparatus, unless under and in accordance with a licence granted by Ofcom (also known as a 'wireless telegraphy licence').[46]

5.16 Licence exemptions are set out in delegated legislation, a statutory instrument (regulations) made by Ofcom and published along with all other UK legislation on the National Archives' website. The exemption legislation is subject to Parliamentary scrutiny after it has been made, but it is not subject to a vote in Parliament under negative resolution procedure, nor affirmative resolutions procedure. Ofcom has made many exemption regulations over the years, and a list of key regulations can be found on Ofcom's website.

[43] Though we expect the risk of adjacent band interference to neighbouring countries to be very low.
[44] Ofcom is less concerned about interference risks caused by D2D services to the MNO whose spectrum they are using, as we would expect the MNO in question would ensure that any commercial agreement the reach with a satellite provider includes arrangements to manage interference effectively.
[45] See Section 8(3) WTA.
[46] Section 8(1) WTA. There are also limited exceptions where section 8(1) does not apply. We do not consider these are relevant to this consultation. See Section 8(2) WTA.

5.17 As noted above, the existing mobile handset exemptions do not apply when a handset is connected to a satellite for D2D services. We have therefore considered whether handsets should be made subject to an exemption for D2D services.

5.18 We acknowledge that the D2D services are new and innovative, and there is not yet a licensing or authorisation option within Ofcom's existing legal framework which provides a perfect fit to enable these services from companies and consumers, and also still provides Ofcom with bespoke regulatory tools and safeguards which match our interference management duties. We are therefore consulting on the regulatory options which we have at hand and are available now under the existing legal framework in the WTA.[47]

The conditions to grant a mandatory licence exemption are not met

5.19 Ofcom must make a station or apparatus licence exempt (under a statutory instrument made by Ofcom) if the criteria set out in the WTA is met.[48] If D2D services met the statutory criteria for exemption, Ofcom would be required to make licence exemption regulations which would exempt mobile handsets which communicate directly with satellites.

5.20 However, we consider that these exemption criteria are not satisfied. Our coexistence analysis suggests that D2D services:

- might cause or contribute to undue (harmful) radio interference to adjacent frequency mobile services operated by other MNOs in the UK if out of band emissions from the satellite exceed certain limits;
- might cause or contribute to undue (harmful) radio interference to adjacent frequency services used by other radio spectrum users in the UK; and
- might cause or contribute to undue (harmful) radio interference in neighbouring countries and other co-channel users in the UK if transmissions from the satellite are not suitably directed through careful beam management.

D2D services could be made available by a discretionary exemption, subject to certain conditions

5.21 Where the criteria for a mandatory licence exemption are not met, Ofcom may nevertheless still use its discretion to make a statutory instrument to make stations or

[47] We note that in a different context bespoke legislation was created for Ofcom, by Parliament, in relation to a specific set of frequencies and satellite uses. This was done under *The Authorisation of Frequency Use for the Provision of Mobile Satellite Services (European Union) Regulations 2010* (S.I. 2010/672). This legislation does not provide any regulatory tools in relation to the services being considered in this document.

[48] See sections 8(4) and 8(5) of the WTA. Ofcom must be satisfied that the station or apparatus is not likely to: (i) involve undue interference with wireless telegraphy; (ii) have an adverse effect on technical quality of service; (iii) lead to inefficient use of the part of the electromagnetic spectrum available for wireless telegraphy; (iv) inhibit the development of effective arrangements for the sharing of frequencies; (v) endanger safety of life; and (vi) prejudice the promotion of social, regional or territorial cohesion; or (vii) prejudice the promotion of cultural and linguistic diversity and media pluralism.

apparatus exempt.[49] Under the legislation, such an exemption may either be absolute ("discretionary absolute exemption"), or be made subject to terms, provisions, or limitations, set out in regulations ("discretionary exemption").

5.22 In order to create any discretionary exemption, Ofcom must be satisfied that doing so is consistent with the general duties set out in section 3 of the Act[50] and section 3 WTA. This includes the requirement to secure the optimal use for wireless telegraphy of the electromagnetic spectrum[51], having regard to factors including the extent to which the spectrum is available for use, current and future demand for that spectrum,[52] and the desirability of promoting the efficient management and use of the spectrum for wireless telegraphy and the development of innovative services.[53] Further, in exercising certain regulatory functions we must have regard to the desirability of promoting economic growth.[54]

5.23 Additionally, where we make an exemption subject to terms, provisions or limitations, any such restrictions must be objectively justifiable, must not unduly discriminate, and must be proportionate and transparent.[55]

We do not think that a discretionary absolute licence exemption for D2D services would enable us to meet our duties

5.24 We first considered whether a discretionary, absolute licence exemption would enable us to discharge our duties and enable us to address our interference concerns. A discretionary, absolute exemption would exempt all mobile handsets connecting to D2D services, without imposing any terms, provisions or limitations on the delivery of D2D services.

5.25 As identified above, we have concerns about interference that D2D services might cause in the UK to adjacent frequency mobile services operated by other MNOs and to adjacent frequency services used by other non-mobile radio spectrum users. We are also concerned that D2D services might cause radio interference to other co-channel users in the UK and in neighbouring countries if transmissions from the satellite are not suitably directed through careful beam management.

5.26 An absolute licence exemption would not enable Ofcom to impose any conditions relating to the delivery of the D2D services in the UK (for example requiring coordination with adjacent frequency services). We therefore consider that an absolute exemption would not enable us to address the interference concerns identified, nor to adequately fulfil our spectrum management duties.

5.27 We also note that an absolute licence exemption would not place any direct obligation on the MNO and Satellite Operators providing the D2D services. We are concerned that in

[49] Section 8(3) WTA. Ofcom's principal duty is to carry out its functions to further the interests of (i) citizens in relation to communications matters; and (ii) consumers in relevant markets, where appropriate by promoting competition.
[50] Section 3(1) CA03.
[51] Section 3(2)(a) CA03.
[52] Section 3(4) CA03.
[53] Section 3(2) WTA.
[54] Section 108, Deregulation Act 2015. Section 111 defines 'regulatory function'. The Economic Growth (Regulatory Functions) (Amendment) Order 2024 applies the duty set out in s 108 to Ofcom.
[55] Section 8(3B) WTA.

these circumstances, the parties providing the D2D services would not be incentivised to proactively manage the risk of interference from the operation of the D2D network. Further, should such interference occur, Ofcom would have a limited ability to take enforcement steps against the parties providing the D2D service to ensure the timely resolution of any interference.

5.28 For these reasons we do not propose to create a discretionary, absolute licence exemption for mobile handsets connecting to D2D services.

5.29 We have therefore considered whether a discretionary exemption, subject to terms, provisions and limitations might better enable us to manage to interference risk and to meet our duties.

Option one: Licence exemption for mobile handsets connecting to a D2D service that complies with technical and non-technical conditions

5.30 The first authorisation option which we have identified is to create a discretionary licence exemption for mobile handsets that connect to D2D services that comply with conditions, which would be specified in a schedule to the exemption.

5.31 Handsets that connected to networks which did not comply with those conditions, would therefore not be licence exempt.

5.32 In particular, we would propose to include conditions relating to the following:

a) The permitted frequencies on which the D2D services can be provided;
b) The geographic boundary of the exemption;
c) Coordination; and
d) Record keeping and reporting.

5.33 We consider that requiring conditions on D2D services is proportionate to the risk of harmful interference. However, as discussed below, there is a risk to Ofcom's ability to enforce in the event of breaches. Therefore, the proposal may insufficiently address concerns around interference.

5.34 While this option goes some way to creating a mechanism for spectrum management by setting out the parameters within which we expect the D2D service to operate, it does not place a direct formal obligation on the parties providing the D2D services.

5.35 In the event that the D2D service did not meet the exemption conditions, the exemption would no longer be valid, and it would become unlawful for consumers to continue using their handsets to connect to the D2D network. Practically speaking, we would not expect to seek redress via those consumers, but we would expect the parties providing the D2D services to take steps to remedy the interference or, in the alternative, withdraw the D2D service.[56] We consider that the resulting reputational damage to the D2D operators for failure to comply and withdrawal of the service would be likely to provide an incentive to avoid this occurrence.

5.36 However, should a breach of the conditions occur, Ofcom would have a limited ability to take direct legal enforcement steps against the parties controlling the likely cause of

[56] This could be done by the MNO disabling the service via its control over the SIM, and/or, via its commercial agreement with the Satellite Operator.

interference to ensure the timely resolution of any interference. It is for this reason that this is not our preferred authorisation option.

5.37 Under this option, the process for updating or creating new exemption regulations includes a consultation, which could take a minimum of 10 weeks.

Option two: Licence exemption for mobile handsets connecting to D2D services provided by an MNO which has an existing licence varied to include 'D2D coordination clauses'

5.38 Our second authorisation option is to create a discretionary licence exemption for mobile handsets that connect to D2D services provided by an MNO whose existing mobile spectrum licence for the spectrum used for D2D services has been varied to include the necessary clauses for the provision of D2D services.

5.39 Under this option we would propose that any MNO wishing to provide D2D services would request Ofcom to vary its existing wireless telegraphy licence(s) relating to the band(s) proposed for use for D2D services.

5.40 As part of the MNO's request to vary its licence, we would expect the MNO to provide details of the frequencies they intend to use for D2D, evidence of the MNO's ability to comply with our proposed technical conditions (see Section 4) and evidence of a commercial agreement between the MNO and the Satellite Operator which includes clauses requiring the Satellite Operator's compliance with the proposed technical conditions.

5.41 On receipt of this information, we would also assess whether further technical conditions would be necessary to protect other spectrum users in adjacent spectrum.

5.42 Following a review of the above, we would consider whether we could immediately vary the licence, taking account of our duties. However, we may consider whether any additional short consultation period might be required, if for example there were more complex adjacent band coexistence arrangements.

5.43 In parallel with the variation process, we would consult on creating a new licence exemption. This would take approximately three months to complete. The exemption regulations would then be enacted by Ofcom so that mobile handset users connecting to D2D services provided by the MNO in compliance with the coordination clauses would be covered by the exemption.

5.44 This approach to authorisation would enable us to address the interference concerns identified by taking direct enforcement action to require the MNO to meet the specified technical conditions in the licence. It would also enable us to meet our duties by providing us with a direct enforcement mechanism with the MNO to ensure the timely resolution of any interference, as the MNO is able to control the SIM of a handset and can withdraw the ability to connect to the D2D service.

5.45 We consider that this approach is proportionate to the risks of harmful interference, without imposing a significant burden on stakeholders.

Option three: a D2D terminal licence, jointly held by the MNO and Satellite Operator; no licence exemption

5.46 The third authorisation option which we have identified is to create a user terminal licence for the use of mobile handsets which would connect and transmit directly to the satellite

component of the D2D system. Our preference would be that the licence is held by both the MNO and the Satellite Operator.

5.47 A wireless telegraphy licence may be granted by Ofcom subject to such terms, provisions and limitations as Ofcom thinks fit.[57] Such a licence may be granted in relation to a particular station, a particular apparatus, or in relation to any station or apparatus that may be installed or used in the station.[58]

5.48 With respect to apparatus, Ofcom may include limitations relating to the apparatus that may be installed or used and the places where, the purpose for which, the circumstance in which, and the persons by whom the apparatus may be used.[59] The terms, provisions and limitations in a licence may also include terms, provisions and limitations as to strength or type of signal, as to times of use and as to the sharing of frequencies.[60]

5.49 In order to impose terms, provisions and limitations we must be satisfied that the conditions must be objectively justifiable, must not unduly discriminate, and must be proportionate and transparent[61].

In this model MNOs would be licensees and confer the benefit of the licence onto each handset user

5.50 As noted above, we expect that D2D services will be provided in the UK by MNOs and Satellite Operators working together under a commercial arrangement.

5.51 On this basis, we propose to make user handset terminal licences available to the MNO (i.e. the holder of the relevant mobile spectrum licence). This is objectively justified because it is the MNO which has a degree of control over the handset, and therefore would be able to take measures to mitigate interference by limiting the ability for handsets to communicate with the satellite through management of configurations stored on the SIM and messages sent from the MNO network core.

5.52 However, although the MNO has a degree of control over the handset, it is the consumer, not the MNO, which will operate the handset. We consider that to give effect to the licence, such that each consumer is able to lawfully use D2D services, the MNO must "confer the benefit of the licence" onto each consumer with which it has entered into a contract, by giving express authorisation to do so in the contract between the MNO and the consumer.

5.53 This is expressly permitted by the WTA, in circumstances where the ability to confer such a benefit is included as a licence term.[62] Ofcom has enabled this ability in several types of licence since this was permitted by the legislation. It has often been described as "leasing" the spectrum rights.[63]

5.54 We therefore propose to include a licence condition which permits the MNO to confer the benefit of its licence to each of its customers.

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[57] Section 9(1) WTA.
[58] Section 9(5) WTA.
[59] Section 9(3) WTA.
[60] Section 9(4)(a) WTA.
[61] Section 9(7) WTA.
[62] Section 30A WTA.
[63] See Ofcom's website for more details.

5.55 This is also consistent with our background legal duty[64] to allow the licence holder to confer the benefit of the licence on another person or to transfer the rights and obligations arising as a result of the licence to another person.[65]

5.56 There may be a circumstance in which future licensees wish to permit other networks to use their D2D services. For example, this may include enabling MVNO use of the D2D services. In this case, we would anticipate that this would be achieved by a commercial arrangement between the licensees and the MVNO. This would include an arrangement to confer the benefit of the licence to (i) the MVNO and (ii) the MVNOs customers, as sub-licensees. We therefore propose to include a condition which enables the licensees to confer the benefit of the licence to 'sub-licensees'.[66]

5.57 We recognise that the requirement to confer the benefits of the licence to (i) MNO customers, (ii) MVNOs, and (iii) MVNO customers, may create additional burdens on licensees in comparison to option 2.[67]

In this model our preference would be that Satellite Operators should also be licensees given the direct control over the satellite downlink

5.58 Under this option our preference would be that the Satellite Operator which intends to provide the D2D service into the UK should also be included on the licence as a joint licensee with the MNO. We welcome views from stakeholders on this, and the commercial practicality of it.

5.59 This approach is similar to our approach to satellite earth station network licensing, in that it ensures that the licensees have direct control of the different elements of the network and provides Ofcom with a direct enforcement mechanism in the event of any interference. We have identified the following spectrum management advantages to having the Satellite Operator as a joint licensee:

- If the Satellite Operator were not a joint licensee Ofcom would have to solely rely on the contractual relationship between the MNO and Satellite Operator to address potential undue (harmful) interference arising from the actions of the Satellite Operator. If the satellite operator were to be a joint licensee, then the Satellite Operator would have to meet any requirements set out in the licence relating to the satellite segment to avoid licence enforcement or revocation and Ofcom would have a

[64] The general duty under section 30A gives effect to EECC Directive, which recognises that “network infrastructure sharing, and in some instances radio spectrum sharing, can allow for a more effective and efficient use of radio spectrum and ensure the rapid deployment of networks”.
[65] Section 30A(1) WTA. This applies where Ofcom is using its powers under section 9 WTA to impose terms, provisions and limitations on a wireless telegraphy licence (which is the case in this document) and using its power to make regulations under section 30 WTA (see section 30A(2) WTA). This duty is subject to limited exceptions as set out in section30A(4).
[66] We note that should any future licensees wish to enable 999 emergency services roaming for its D2D services, there may be occasional instances where a customer could make a call to the emergency services using D2D services via a network with which the customer does not have a contract. In this case, the customer in question will not have the benefit of the licence for D2D services conferred upon them. However, we do not consider that it is proportionate to address this with our regulations at this time, as we consider this is likely to be an edge case which will occur infrequently.
[67] We also discuss this in our Impact Assessment in Annex 2.

direct route to enforcement against the Satellite Operator in the event of any interference.

- If the Satellite Operator were not a joint licensee, then it might be harder for Ofcom to effectively ensure that interference is mitigated. We consider that we need to be able to set out technical conditions on the satellite component of the network in the licence.

5.60 It is therefore our preference that the relevant Satellite Operator would take the licence alongside the MNO with which it has formed a commercial partnership.

5.61 We consider that this approach is proportionate to the risks of harmful interference, though we recognise there is a risk that this option is more burdensome to implement for stakeholders by requiring additional administrative and contractual steps.

Our preferred approach

5.62 Whilst all three options set out above have merit, and are objectively justified, non-discriminatory, and proportionate, our preferred authorisation approach is Option two i.e. a discretionary exemption for mobile handsets that connect to D2D services provided by an MNO, whose wireless telegraphy licence has been varied to include coordination clauses for the provision of D2D services

5.63 When compared to Option one, Option two does carry a slightly higher regulatory burden as it requires the MNO to request a licence variation, but similar to Option one, would require us to follow the statutory process for updating, or creating, new exemption regulations, which could take a minimum of 10 weeks. However, under Option one, Ofcom would have limited ability to take direct enforcement action in the event of any interference and we would be less able to fulfil our spectrum management duties. Option two allows us to take direct regulatory enforcement over the MNO. For this reason, we have a preference for Option two over Option one.

5.64 We also believe Option two to be preferable to Option three because it avoids the need for MNOs to confer the benefits of the terminals licence to their end users, and for MVNOs and other operators making use of the D2D network to confer the benefits of the licence to their end users. This reduces the regulatory burden on the operators.

5.65 Option three does have the advantage that the Satellite Operator is a joint holder of the terminal licence and so would be subject to direct regulatory enforcement by Ofcom in the event that licence conditions are breached. However, under Option two, the MNO, through its commercial contract, could require the Satellite Operator to comply with the relevant conditions. We consider that this would provide sufficient certainty that the Satellite Operator will take timely and effective action to address interference.

Do you agree with our preferred authorisation approach (Option two)? If not, please set out your reasoning.

Are there any alternative authorisation options, not discussed here, that you believe are worth considering?

6. Proposed conditions

6.1 In this section, we set out the conditions that we propose to implement as part of our authorisation framework. The purpose of an authorisation mechanism is to achieve coexistence between new D2D services and existing spectrum users, allow Ofcom to monitor compliance with the conditions and act, should harmful interference occur.

6.2 As set out in section 5, each authorisation option we have proposed includes a different combination of conditions in order to manage any potential harmful interference and enable us to meet our duties.

6.3 Table 6.1 below sets out which conditions that we propose apply to each authorisation option (together referred to below as 'authorisation mechanisms'). To recap, we have identified the following authorisation options:

- **Option one**: A discretionary licence exemption for mobile handsets that connect to D2D services that comply with conditions specified in the exemption.
- **Option two**: A discretionary licence exemption for mobile handsets that connect to D2D services provided, in part, by an MNO whose wireless telegraphy licence has been varied to include coordination clauses for the provision of D2D services.
- **Option three**: A user terminal licence for the use of mobile handsets which would connect and transmit directly to the satellite component of the D2D system, jointly held by the MNO and the Satellite Operator.

Table 6.1: Overview of the proposed conditions that would apply to each authorisation option

Condition	Option one	Option two	Option three
Frequency	✓	✓	✓
Duration		✓	✓
Geographical boundaries	✓	✓	✓
Coordination with co-channel and adjacent spectrum users	✓	✓	✓
International cross-border coordination	✓	✓	✓
Non-interference, non-protection	✓	✓	✓
Record keeping and reporting	✓	✓	✓
Modification, restriction, and closedown		✓	✓
Fees			✓

Frequency

6.4 Operators would be authorised to use only the specific frequencies set out in their request to offer D2D services in the UK. We would require the D2D operator(s) to specify the blocks of spectrum (i.e. specific frequencies within a band) they intend to use within each mobile band.

6.5 We do not propose to include all mobile bands in each authorisation, as this would require us to undertake a detailed assessment of all the bands prior to issuing any authorisation, even if the Satellite Operator did not plan to use them. Our proposed approach is intended to reduce the time it will take for us to assess an application, enabling earlier decisions and service roll out, and allow us to monitor compliance more efficiently.

6.6 A separate application would be required for the operators to deploy D2D services in a different, or additional, bands.

Duration

6.7 As noted above, we propose to review any framework in line with international decisions made after WRC-27. On this basis, we propose that any licence granted under option 3, or licence variation granted under option 2, would be valid until 2028. We would also review any exemption (options 1 and 2) after that time.

6.8 We believe this provides a sufficient period for deployment of these services in the UK prior to WRC-27 and ensures a degree of operational certainty.

Geographical boundaries

6.9 We propose that any authorisation mechanism would allow use of equipment within the United Kingdom and territorial seas. This would enable service to 12 nautical miles, thereby delivering value associated with enabling connectivity in coastal waters, whilst providing some protection to offshore co-channel licensees. This territory is consistent with the MNOs existing national spectrum licences.

6.10 Any authorisation would not authorise D2D services to be provided in the Channel Islands or the Isle of Man. This is consistent with the existing MNOs' licences. Authorisation in these territories would require further discussions with, and agreement from, the relevant island authorities.

Coordination with co-channel and adjacent spectrum users

6.11 Our proposals and technical analysis are based on D2D services being provided to unmodified mobile handsets.

6.12 D2D services must only be provided to User Equipment that meets the technical specifications set out in the relevant Interface Requirement documents listed in the existing MNO mobile spectrum licences.

6.13 There would be a requirement to meet the power limits for protecting other mobile networks set out in Table 6.2 in parts of the UK where Ofcom has issued co-channel Local Access or Offshore Network licences. These limits can be exceeded if coordination agreements are reached with the impacted licence holders.

6.14 For more detail on the location of, and spectrum used by, Local Access and Offshore Network licences, please see Annex A5.

6.15 In addition to power limits required to protect co-channel Local Access and Offshore Network licences, D2D operators will be required to meet power limits set out in Table 6.2 for adjacent channel MNOs and other spectrum users.

Table 6.2: Proposed power limits for D2D satellite unwanted emissions in mobile downlink spectrum. These power limits would apply at the surface of the earth and apply for out of area and adjacent channel mobile networks

Mobile Band	PFD Limit in mobile downlink spectrum
MHz	*dBW / MHz / m^2*
700, 800, 900	-119
1400	-113
1800, 2100	-111
2600	-108

6.16 The proposed power limits to protect mobile networks are set out in Table 6.2. Power limits for other spectrum users will be set by Ofcom as part of the authorisation request, based on the coexistence analysis set out in table 4.4.

Table 6.3: Proposed minimum elevation angle for D2D satellite emissions. This limit would apply to each point at the surface of the earth in the D2D service area relative to the satellite providing the best serving beam at each point

Mobile Band	Minimum elevation angle of transmission
MHz	*degrees*
All	20

6.17 Ofcom may impose more restrictive conditions than those given in Table 6.2 if more than one D2D provider seeks to operate in a given mobile band. This would be because we would need to apportion the interference limit between the D2D providers in the band as described in *Apportionment* in Section 4. Ofcom may also introduce more restrictive conditions reflecting apportionment to the existing D2D provider(s) in a mobile band as well as the new entrant.

6.18 Ofcom may impose additional technical conditions necessary to protect other spectrum users, should we consider it necessary to undertake a further detailed coexistence assessment, once we identify which mobile band(s) are most interesting to prospective D2D providers, based on responses to this consultation and requests for an authorisation. These

conditions will be developed based on any specific risks associated with the planned D2D network (see section 4 for our initial assessment of risk to other spectrum users).

International Cross-Border Coordination

6.19 Any authorisation would require that the Radio Equipment is operated in compliance with such cross-border co-ordination and sharing procedures as may be notified to the authorised party by Ofcom from time to time.

6.20 The protection criteria set out in Tables 6.2 and 6.3 above should be met at the border or coastline of neighbouring countries as appropriate. This requirement would not negate or replace the Satellite Operator's obligations under Article 4.4 of the Radio Regulation to operate on a non-interference, non-protection basis. Neighbouring administrations may consider that more or less stringent protection criteria are necessary to protect their mobile networks.

Non-interference, non-protection

6.21 Operation of the radio equipment should be on a non-interference, non-protection basis. This means the operator would have to cease transmissions immediately if it caused harmful interference into another service.

Record keeping and reporting

6.22 As this is a new service for which the technology is evolving, we are proposing record keeping and reporting requirements that will allow Ofcom to fulfil its duties in relation to spectrum management and reporting on availability of services in the UK.

6.23 We propose that the D2D operator(s) should compile and maintain accurate written records of:

a) A coverage map of service in the UK, showing the predicted PFD (power flux density) on the ground for the best serving beam, at a resolution of 100m/sq pixels[68] and confirming that there are no pixels within the service area that are at less than 20 degrees elevation relative to the satellite providing the best serving beam.
b) A coverage map of service in the UK, showing the predicted aggregate pfd (power flux density) on the ground from all beams, at a resolution of 100m/sq pixels.
c) A map of unwanted transmissions outside of service areas in the UK, showing the predicted aggregate pfd (power flux density) on the ground from all beams, at a resolution of 100m/sq pixels and at a distance of up to 100km from the boundary of each service area.
d) The out of block and out of band spectrum masks associated with each beam.

6.24 Where information in a-d changes (e.g., as a result of upgrades to technology or the satellite constellation), a date-stamped historic record must be maintained.

[68] This 100m/sq pixel grid size has been specified to align with methodology use to request data from the terrestrial mobile networks. Grids are based on the OSGB grid references by the lower left-hand corner.

6.25 We propose that the D2D operator(s) must keep records that demonstrate how they have complied with any coordination procedures identified in the relevant provisions of the authorisation, including any coordination calculations.

6.26 The operators must produce these records if requested by Ofcom, or a person authorised by Ofcom.

Modification, restriction, and closedown

6.27 Under options two and three, the licences would include a condition that reserves to Ofcom the right to require the licensee(s) to modify, restrict or close down the use of its radio equipment, should we have reasonable grounds to believe that the licensee(s) has breached the terms of its licence, or we consider this necessary in the event of a national or local state of emergency being declared. This is a standard clause in most WTA licences issued by Ofcom.

6.28 We may require licensees to modify the use of their radio equipment to aid Ofcom's investigations of potential interference resulting from the operation of the D2D service.

Fees

6.29 We propose that under option 3, any new licence would be subject to a fee, payable every 12 months, which would be cost-based. Demand for D2D services is uncertain, and therefore we do not believe it would be appropriate to set administered incentive prices at present.

6.30 In line with our framework for setting cost-based fees, we would set these fees to reflect our spectrum management costs applicable to these licence products.

6.31 We propose to use the actual per-licence costs associated with a similar licence product. We have looked at our existing licence products and we believe that the Non-Geostationary Earth Station Network (NGSO ESN) licence is the closest to the licensing regime we are proposing, where, similarly to D2D, demand for these services is still emerging. Given these similarities, we would propose to use similar costs associated with the NGSO ESN licence to determine what our D2D licence fee should be. As the fee for the NGSO ESN licence product, which is £200 every year, has been determined on an administrative cost recovery basis, this represents a suitable basis for determining a cost-based fee for this new licence product.

6.32 This proposed condition would only be applicable under option 3, a D2D terminal licence.

Overall, do you agree with the proposed conditions set out in this section?

Authorisation process

6.33 Under all proposed options, we would require the D2D operators to inform us about which of the MNO's licensed bands it intends to utilise to provided D2D services. What other information is also required will depend on which authorisation option is chosen.

6.34 Once we have information relating the MNO's licensed bands, we would consider whether a further coexistence analysis would need to be undertaken prior to progressing towards authorisation. This would be dependent on the frequency bands specified in the request.

7. Next steps

7.1 We invite responses to this consultation by 5pm on 20 May 2025. Annexes A6-A9 include relevant information about how to respond to this consultation.

7.2 Following a review of all responses received, we will publish our final decision on our authorisation approach. We may then undertake a separate consultation on specific elements. We aim to be able to accept requests to offer these services by end 2025.

7.3 For stakeholders that wish to trial services in the UK, these trials can be conducted under our Innovation and Trials licences. These licences operate on a non-interference and non-protection basis for a temporary period. A licence does not allow the deployment of a commercial and/or operational service. The application process is set out on our website.

Do you have any other comments on the proposals set out in this document?

A1. Legal Framework

A1.1 Ofcom's statutory powers and duties in relation to spectrum management are set out primarily in the Communications Act 2003 (the "2003 Act") and the Wireless Telegraphy Act 2006 (the "WTA").

Communications Act 2003

A1.2 Our principal duty is to further the interests of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition.[69] In relation to spectrum, Ofcom is required to secure the optimal use for wireless telegraphy of the electro-magnetic spectrum and the availability of a wide range of electronic communications services throughout the United Kingdom.[70]

A1.3 In performing its duties, Ofcom also has to have regard to a number of factors as it appears relevant in the circumstances, including the desirability of promoting competition and encouraging investment and innovation in relevant markets and the interests of everyone who may wish to use the spectrum for wireless telegraphy.[71] The Act further provides that Ofcom must in all cases have regard to the principles of transparency, accountability, proportionality, and consistency, as well as ensuring that its actions are targeted only at cases in which action is needed.[72]

Wireless Telegraphy Act 2006

A1.4 In carrying out our spectrum functions, we have a duty under the WTA to have regard, in particular, to the extent to which the spectrum is available for use (or further use) for wireless telegraphy, the demand for use (or further use) of that spectrum for wireless telegraphy and the demand that is likely to arise in future for the use (or further use) for wireless telegraphy.[73]

A1.5 We also have a duty to have regard, in particular, to the desirability of promoting the efficient management and use of the spectrum for wireless telegraphy, the economic and other benefits that may arise from the use of wireless telegraphy, the development of innovative services, and competition in the provision of electronic communications services.[74]

A1.6 We permit the use of the radio spectrum by granting wireless telegraphy licences under the Wireless Telegraphy Act. It is unlawful and an offence to install or use wireless telegraphy apparatus without holding a licence granted by Ofcom, unless the use of such equipment is exempted.

[69] Section 3(1) of the 2003 Act.
[70] Section 3(2) of the 2003 Act.
[71] Section 3(4) of the 2003 Act.
[72] Section 3(3) of the 2003 Act.
[73] Section 3(1) WTA.
[74] Section 3(2) WTA.

Ofcom's authorisation regime

A1.7 Under section 8 of the WTA, and subject to some exceptions, it is unlawful to establish or use a wireless telegraphy station or to install or use wireless telegraphy apparatus, unless under and in accordance with a licence granted by Ofcom[75] (also known as a 'wireless telegraphy licence'), unless Ofcom has made regulations which exempt the establishment, installation or use of wireless telegraphy stations or wireless telegraphy apparatus from the requirement of having a licence.[76]

Licensing

A1.8 Ofcom has the power to grant a wireless telegraphy licence in relation to a particular station or particular apparatus or in relation to any station or apparatus described by the wireless telegraphy licence itself.[77]

A1.9 A wireless telegraphy licence may be granted by Ofcom subject to such terms, provisions, and limitations as Ofcom thinks fit.[78] In the case of a wireless telegraphy licence to establish a station, the limitation may in particular include limitations to position and nature of the station, the purpose for which the circumstances in which and the person by whom the station may be used and the apparatus that may be installed or used in the station.[79]

A1.10 In the case of other licences the limitations may, in particular, include limitations to the apparatus that may be installed or used and the places where, the purpose for which, the circumstances in which and the persons by whom the apparatus may be used.[80]

A1.11 Ofcom has the power to impose terms, provisions and limitations to the extent that it is satisfied that these are: [81]

- objectively justifiable in relation to the networks and services to which they relate;

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

- proportionate to what we want to achieve; and
- transparent in relation to what they are intended to achieve.

[75] This is subject to some exceptions including the use of a television receiver for receiving a television programme or the installation of a television receiver for use solely for that purpose (section 8(2) WTA).
[76] Section 8(3) WTA.
[77] Section 9(5) WTA.
[78] Section 9(1) WTA.
[79] Section 9(2) WTA.
[80] Section 9(3) WTA.
[81] Section 9(7) WTA.

Exemptions

Ofcom must make a station or apparatus licence exempt (under a statutory instrument made by Ofcom) if the criteria set out in the WTA is met.[82] Where these criteria are not met, Ofcom use its discretion to make a statutory instrument to make stations or apparatus exempt. Such an exemption may either be absolute, or be made subject to terms, provisions, or limitations, set out in regulations. Any discretionary exemption must be consistent with Ofcom's duties set out in section 3 of the 2003 Act and section 3 of the WTA (see above). Additionally, any exemption made subject to terms, provisions or limitations, any such restrictions must be objectively justifiable, must not unduly discriminate, and must be proportionate and transparent.[83]

Ofcom's powers to set fees

A1.12 Under section 12 of the WTA, Ofcom has power to require licensees to pay fees to Ofcom on the grant of a licence and subsequently at such times during the licence term.[84] The requirement to pay fees at times after the grant of a licence must be imposed by way of regulations made by Ofcom.[85] The timing of the fee payment must be set out in the regulations,[86] and the amount of the fee can be prescribed in the regulations, or alternatively the regulations may provide for the amount to be determined by Ofcom in accordance with the regulations.[87]

A1.13 Section 13 of the WTA provides that Ofcom can set fees at an amount that is higher than the cost to us of carrying out our radio spectrum functions, if we think that is appropriate, in particular in light of our statutory duties in section 3 of the WTA.[88]

A1.14 Section 122 of the WTA is a general provision about matters relating to Ofcom's powers to make statutory instruments (including fees regulations under section 12 of that Act). It includes a requirement that where we are proposing to make regulations, we must publish a notice setting out the general effect of the regulations[89] and give a period of at least one month within which representations on the proposed regulations may be made to us.[90]

[82] See sections 8(4) and 8(5) of the WTA. Ofcom must be satisfied that the station or apparatus is not likely to: (i) involve undue interference with wireless telegraphy; (ii) have an adverse effect on technical quality of service; (iii) lead to inefficient use of the part of the electromagnetic spectrum available for wireless telegraphy; (iv) inhibit the development of effective arrangements for the sharing of frequencies; (v) endanger safety of life; and (vi) prejudice the promotion of social, regional or territorial cohesion; or (vii) prejudice the promotion of cultural and linguistic diversity and media pluralism.
[83] Section 8(3B) WTA.
[84] Section 12(1) WTA.
[85] Section 12(1)(b) WTA.
[86] Section 12(1)(b) WTA.
[87] Section 12(2) WTA.
[88] Section 13(2) WTA.
[89] Section 122(5) WTA.
[90] Section 122(6) WTA.

UK Government's Statement of Strategic Priorities

A1.15 Under section 2B(2) of the Communications Act, when exercising our functions relating to telecoms, management of radio spectrum and postal services, we are required to have regard to the UK Government's Statement of Strategic Priorities (SSP) that has been laid before Parliament and designated by the Secretary of State (or any subsequent amended or replacement SSP that has been so laid and designated). The current SSP for telecommunications, the management of radio spectrum, and postal services was designated on 29 October 2019, having been laid in draft before Parliament on 18 July 2019. See section 3 for how we have taken account of the SSP in developing our proposals.

The desirability of promoting economic growth

A1.16 In exercising our regulatory functions, we are also required to have regard to the desirability of promoting economic growth (the "growth duty").[91] In particular, we must consider the importance for the promotion of economic growth of exercising the regulatory function in a way which ensures that regulatory action is taken only when it is needed, and any action taken is proportionate. Section 110(3) of the Deregulation Act 2015 requires us to have regard to the "Growth Duty: Statutory Guidance" (revised by Government in May 2024). See Section 3.

[91] Section 108 of the Deregulation Act 2015, which was extended to Ofcom's regulatory functions by The Economic Growth (Regulatory Functions) (Amendment) Order 2024.

A2. Impact assessments

A2.1 Section 7 of the Communications Act 2003 requires us to carry out and publish an assessment of the likely impact of implementing a proposal which may significantly affect businesses or the public, or when there is a major change in Ofcom's activities.

A2.2 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.

A2.3 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.[92]

A2.4 The relevant duties in relation to the proposal on which we are consulting are set out in Annex A1.

A2.5 The remainder of this annex contains (i) our assessment of the impact of the proposals set out in the main body of this document, (ii) our assessment of the equality impact of these proposals, and (iii) Welsh language considerations.

Impact assessment

A2.6 We are consulting on the ways in which we could introduce a flexible authorisation framework to authorise D2D satellite services to mobile handsets using MNO radio spectrum, covering most of the bands used by UK MNOs below 3 GHz. Under these proposals:

- D2D services could only be provided by Satellite Operators working with the MNO who is licenced to use the relevant frequencies nationally.
- D2D services would require a new authorisation that will enable mobile handsets to communicate with a satellite in the licenced bands. This authorisation could be in the form of a licence exemption for handsets connecting to D2D services which comply with conditions specified in the exemption, a variation to the MNO's licence accompanied by a licence exemption, or a new licensing regime.

A2.7 Our view is that the authorisation framework we are consulting on will enable innovative services which could extend to voice, messaging, and data coverage beyond the reach of terrestrial networks, potentially enabling ubiquitous, outdoor coverage. There is also the potential for our proposed framework to support an improved emergency service, as well as provide a degree of resilience to existing mobile services. The technical conditions proposed in this document are designed to protect existing users from the additional interference risks created by the proposed framework.

A2.8 Overall, we consider that authorising D2D services will:

[92] See Ofcom's Impact Assessment Guidance.

a) allow MNOs to increase the utilisation of their licensed spectrum, by giving them the option to provide a greater variety of services from the same spectrum holding;

b) encourage investment and innovation, by making it easier for operators to roll out infrastructure and services in the UK;[93]

c) support competition, by enhancing the ability of MNOs and Satellite Operators to provide a greater variety of communications services to UK customers and consumers; and

d) promote the interests of UK consumers, particularly those living in or visiting rural and remote areas, and those in need of emergency services.

A2.9 As context to this consultation, this authorisation framework is being introduced to enable the early benefits of D2D to be delivered by providers that are either ready or soon-to-be ready to supply these services. We currently envisage that we will review the authorisation framework following World Radio Conference in 2027 (WRC27) and may decide to propose changes to the framework.

A2.10 As discussed in section 5, we have considered three Options as authorisation frameworks. We re-cap these here:

- Option One: A discretionary licence exemption for mobile handsets that connect to D2D services that comply with conditions, which would be specified in a schedule to the exemption.
- Option Two: A discretionary licence exemption for mobile handsets that connect to D2D services provided by an MNO whose existing mobile spectrum licence for the spectrum used for D2D services has been varied to include the necessary clauses for the provision of D2D services.
- Option Three: A user terminal licence for the use of mobile handsets which would connect and transmit directly to the satellite component of the D2D system, jointly held by the MNO and the Satellite Operator.

A2.11 Our preferred Option is Option Two, a discretionary exemption for mobile handsets that connect to D2D services provided by an MNO, whose wireless telegraphy licence has been varied to include coordination clauses for the provision of D2D services.

A2.12 As set out in paragraphs 5.62-5.65, our reasoning is that:

a) When compared to Option One, Option Two does carry a slightly higher regulatory burden as it requires the MNO to request a licence variation. However, under Option One, Ofcom would have limited ability to take direct enforcement action in the event of any interference and we would be less able to fulfil our spectrum management duties. Option Two allows us to take direct regulatory enforcement over the MNO. For this reason, we have a preference for Option Two over Option One.

b) We also believe Option Two to be preferable to Option Three because it avoids the need for MNOs to confer the benefits of the terminals licence to their end users, and for

[93] We consider that Satellite Operators may be more likely to deploy or expand capacity at gateways in the UK, as a result of this authorisation product.

MVNOs and other operators making use of the D2D network to confer the benefits of the licence to their end users. This reduces the regulatory burden on the operators.

c) Option Three does have the advantage that the Satellite Operator is a joint holder of the terminal licence and so would be subject to direct regulatory enforcement by Ofcom in the event that licence conditions are breached. However, under Option Two, the MNO, through its commercial contract, could require the Satellite Operator to comply with the relevant conditions. We consider that this would provide sufficient certainty that the Satellite Operator will take timely and effective action to address interference.

A2.13 For the remainder of this impact assessment, we focus on the risks, benefits, and costs of Option Two. Below, we discuss how Option Two and the associated conditions set out in this document may affect relevant stakeholders, including UK citizens and consumers.

Impact on current and future spectrum users

MNOs

A2.14 We have considered the potential impacts of Option Two on other MNOs in the UK, specifically: MNOs interested in partnering with Satellite Operators to provide D2D services, MNOs using spectrum adjacent to D2D-licenced spectrum, and competition between MNOs.

A2.15 Option Two allows MNOs to use existing spectrum holdings in new and innovative ways by voluntarily partnering with Satellite Operators. Therefore, should an MNO choose to partner with a Satellite Operator, from that MNO's perspective the proposal is likely to be commercially beneficial when compared to a counterfactual with no authorisation product.[94]

A2.16 We recognise that new satellite transmissions for D2D services could pose a risk of interference to third party MNOs operating in adjacent spectrum. As a mitigation, the proposed technical conditions include a requirement that D2D service providers adjust the power of their transmissions and offer sufficient protections of MNOs operating in adjacent spectrum (see section 4).

A2.17 We have considered whether Option Two could negatively impact competition among MNOs. One potential theory of harm is that any imbalances in the marketplace, if there were any, may be amplified. For example, there may be a limited number of Satellite Operators that could provide a credible D2D service, and if D2D is an important aspect of future competition, there could be a theoretical risk that our Option Two worsen the situation. We do not consider this to be likely:

a) First, in response to Ofcom's CFI, several Satellite Operators expressed an interest in providing D2D services in the UK. In addition, one Satellite Operator may contract with multiple MNOs under our proposals. Therefore, if an MNO wants to enter commercial

[94] This benefit also applies to Option One and Option Two.

agreements with a Satellite Operator, then under Option Two it will not be restricted in its choice of Satellite Operator partner(s).[95]

b) Second, we recognise that if there are, or will in future be, exclusivity arrangements between MNOs and Satellite Operators,[96] this could reduce the number of prospective Satellite Operators in the marketplace. Our view is that this possibility could arise under each of the three authorisation Options we discuss in this consultation document, and so is not unique to our preferred Option Two. Moreover, for exclusivity agreements to be a significant concern, there would need to be one or two must-have Satellite Operators. Our current understanding of the marketplace is that this is not the case.

c) Third, while we recognise that there are significant potential benefits from D2D authorisation using mobile bands, it is unclear that this will be a key competitive factor for UK MNOs, given the uncertainty over D2D capabilities.

A2.18 Option Two also preserves flexibility by not precluding the MNOs and Satellite Operators from providing D2D services to MVNOs, and not precluding the MNOs and Satellite Operators from providing D2D roaming services, such as 999 emergency calls. In addition, Option Two should not limit MNOs' ability to switch its Satellite Operator partner(s) and vice versa.[97]

Other spectrum users in the UK

A2.19 Similar to MNOs operating in adjacent bands, other spectrum users could also face risks of interference from new satellite services. As set out in section 4, we have carried out a high-level coexistence assessment for non-mobile users adjacent to each of the mobile bands. Our analysis shows that D2D services in some mobile bands may give rise to higher coexistence challenges than in other bands (see paras 4.33-4.38). We would consider conducting a more detailed coexistence assessment once we identify which mobile band(s) are of most interest to prospective D2D providers. Our technical approach to authorising bands will take account of differential interference risks and is intended to avoid undue interference being caused to adjacent spectrum users. In practice, this is likely to mean that additional technical conditions would be required for any proposed D2D use of spectrum bands adjacent to services which are likely to be at greater risk of interference from D2D satellite transmissions.

Cross-border users

A2.20 We recognise that the provision of satellite communications may also pose risks of interference to co-channel users outside of the UK border. As set out in paragraphs 4.29-4.32, we are proposing power limits that are more conservative than the existing cross-border coordination trigger thresholds for all but the 2100 MHz band. We would expect that any future D2D providers engage with neighbouring administrations and ensure their transmissions do not cause cross-border interference.

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[95] Accordingly, even if one particular Satellite Operator was the preferred partner for MNOs, multiple MNOs could in principle work with such a Satellite Operator, provided the Satellite Operator's satellite capacity is not a limiting factor.

[96] For example, under an exclusivity agreement an MNO may requires that a Satellite Operator provides an exclusive service to that MNO.

[97] This is subject to any commercial agreements between the MNO and the Satellite Operator.

Satellite providers of D2D services

A2.21 Option Two will enable Satellite Operators to roll out D2D services in the UK, and therefore will likely encourage innovation and investment by Satellite Operators.

A2.22 As the industry is nascent, we have considered whether and how this Option may impact competition among Satellite Operators of D2D services.

A2.23 We recognise that Option Two may pose a limit on the number of Satellite Operators that can partner with an MNO: Satellite Operators will need to obtain the necessary spectrum from the three MNOs in the UK.[98] However, we do not consider that this will distort competition among Satellite Operators providing D2D services since:

a) Under this Option, all Satellite Operators who are interested in providing D2D services in the UK are free to compete with one another to partner with UK MNOs. In turn, MNOs have an incentive to choose the Satellite Operator(s) which best meets their needs, which we expect would encourage competition between Satellite Operators.

b) In addition, while we recognise that we intend to review and may make changes to our authorisation framework in three years, and that this provides less investment certainty compared to a longer time period, this also allows us to revise the framework in future in case any competition issues arise.

A2.24 In principle, the existence of a must-have MNO could raise competition concerns, especially if there are exclusivity arrangements in place in the industry. However, our view is that this is unlikely to be a concern, at least in the short run. First, the UK will have three MNOs with a similar size, and we are not aware of any evidence that there is one MNO that would be the preferred partner to a Satellite Operator.[99] Second, Option Two is flexible, and so there is no limit on the number of Satellite Operators that an MNO could partner with, in principle.

A2.25 As mentioned in A2.18, our preferred Option is sufficiently flexible to allow the MNO or Satellite Operator to change partners over time. This step has been taken to minimise the risk of creating regulatory barriers to switching or entry.

A2.26 We believe our proposed technical conditions are proportionate to mitigate risks and negative impact on other users, while not overly restrictive or preventing the D2D service providers from operating effectively. As explained in section 4, we do not consider that the power limits and other conditions in our proposal to be overly restrictive. Given the risks of interference from D2D service providers on a range of users, we consider that conditions we are proposing to be proportionate for the sufficient protection of other users.

[98] The CMA has cleared the Vodafone / Three merger, subject to legally binding commitments. Provided that the merger process finalises, there will be three MNOs in the UK, namely BT/EE, VMO2, and Vodafone/Three.
[99] Subject to legally binding commitments in the Vodafone/Three merger, the UK will have three MNOs (see also footnote 101. The number of mobile subscribers for the three MNOs are similar: BTEE had 21.1 million subscribers in Q3 2023, VMO2 had 24.1 million subscribers in Q3 2023, Vodafone/Three combined had 27.4 million subscribers in Q3 2023. See pages 26-27 of the CMA's Phase 1 reference decision of the Vodafone/CK Hutchison JV merger inquiry.

Impact on consumers and citizens

A2.27 Our proposed authorisation framework is, to a large extent, motivated by the potential benefits to consumers and businesses that can be delivered by satellite D2D services, which is in line with our duty to further the interests of citizens and consumers in respect to communications matters under the Communications Act 2003.[100]

A2.28 As set out in section 3, satellite D2D services can extend coverage to remote areas of the UK and provide some level of backup to terrestrial services in the event of power outage or natural disasters. As a result, we expect that consumers and businesses will benefit from increased reliability and resilience of mobile connectivity services. In particular, this will benefit consumers and businesses located in or visiting remote areas of the UK. As a result, our authorisation framework may encourage businesses (for example, those with operations in remote areas or UK coastal waters) to invest more in the UK.

Improved access to 999 emergency services

A2.29 As noted in section 3, improved access to 999 emergency services is a key potential benefit for UK citizens of the introduction of D2D services. Given this, we have considered whether to propose conditions that require D2D service providers to provide connections to 999 emergency services for their own customers.[101] We have decided against this step at this time because:

a) There is significant uncertainty over how D2D services are going to be delivered. It may be the case that D2D services will start as an SMS/eSMS service, which could be used for contacting emergency services in remote areas. We do not want to risk limiting such services coming to the market by mandating the provision of voice calls to emergency services.

b) This risk could arise because there are significant additional costs that would be faced by a Satellite Operator to provide a voice service, due to the additional satellite system capacity required. If there are insufficient expected revenues from extending D2D services to include voice calls to emergency services, then mandating this could have a chilling effect on D2D investment at this stage.

A2.30 Having several D2D networks each using a slice of spectrum to enable 999 emergency voice service coverage in the UK may not be an efficient use of spectrum. It may be sufficient that one or two providers deliver this service, with roaming features enabling off-network customers to still gain access to the service.[102] Therefore, mandating coverage now may be a worse approach than waiting to see how the market develops.

A2.31 We recognise a general risk that only one MNO-Satellite Operator provider emerges, and this provider seeks to set monopoly level roaming fees to other MNOs for emergency voice calls. Our view is that this risk would apply whether or not Ofcom required D2D service providers to provide connections to 999 emergency services, and so is not a unique risk to our current proposals. Our view is that if this risk emerges, there would not necessarily be

[100] See paragraph 2.32.
[101] Currently, we expect that if a voice service is offered by an MNO/Satellite Operator using D2D network, the network operators will need to enable 999 emergency voice calls for their customers, according to the General Conditions A.3.
[102] Our proposals do not preclude licence holders providing a 999 emergency services roaming service.

a competition problem. The economics of the industry may not allow more than one MNO-Satellite Operator emergency voice provider. If that is the case, then intervening by regulating roaming fees could have a detrimental impact on competition, by making the service uneconomic and possibly leading to a suspension of the service by the MNO-Satellite Operator. Alternatively, intervening might lead the MNO-Satellite Operator to stop offering roaming, which could make some MNO customers lose access to 999 emergency voice services.

Approaches to implementing Option Two

A2.32 We have considered alternative approaches to implementing Option Two.

a) First, is not authorising satellite D2D until WRC-27 or later. This approach would not deliver the benefits of D2D to people and businesses in the UK in a timely way.

b) Second, is introducing an authorisation framework as soon as we are able, ahead of WRC-27. This approach will deliver benefits to people and consumers in a timely way.[103]

A2.33 We consider that the risks from our chosen approach (i.e. the second implementation approach immediately above) to implementing Option Two are relatively low:

a) Since the spectrum in our proposal is already assigned to MNOs, and MNOs already abide by and manage interference risks, our view is that cooperation between MNOs and Satellite Operators minimises the potential interference risks from this authorisation framework.[104]

b) Consulting on the authorisation Options before WRC-27 means that we allow important services and improvements, such as improved 999 emergency services provision, to come to the UK as soon as practicable.

A2.34 While our chosen approach would allow D2D services to be delivered in a timely manner, it would also allow Ofcom to adjust the framework post 2027 depending on developments in the industry and the outcomes of WRC-27. We recognise that setting a framework with a longer period would provide operators with greater certainty and a stronger incentive to invest. Overall, we consider that our approach strikes a balance between the benefits of a shorter versus longer duration of the proposed framework.

Equality impact assessment

A2.35 We have given careful consideration to whether our decision and proposals will have a particular impact on persons sharing protected characteristics (broadly including race, age, disability, sex, sexual orientation, gender reassignment, pregnancy and maternity, marriage and civil partnership and religion or belief in the UK and also dependents and political opinion in Northern Ireland), and in particular whether they may discriminate against such persons or impact on equality of opportunity or good relations. This assessment helps us

[103] There is also an entirely different option, where we would re-allocate some spectrum from MNOs to Satellite Operators, which would mean revoking part of existing licences held by MNOs. We dismissed this option as it would not be proportionate. It would also not be timely because such revocation would involve a 5-year notice period.

[104] We note that Option Two and Option Three would give Ofcom a more direct way to enforce against an MNO in the event of interference.

comply with our duties under the Equality Act 2010 and the Northern Ireland Act 1998.[105] We have also had regard to the matters in section 3(4) of the 2003 Act.

A2.36 When considering equality, we consider more broadly that persons that share protected characteristics identified in equalities legislation and also consider potential impacts on various groups of persons (see paragraph 4.7 of our impact assessment guidance).[106]

A2.37 In particular, section 3(4) of the Communications Act 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:

A2.38 The vulnerability of children and others whose circumstances appear to us to put them in need of special protection;

A2.39 The needs of persons with disabilities, older persons and persons on low incomes; and

A2.40 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.

A2.41 We consider our decision, and proposals have the potential benefit of facilitating mobile coverage in 'hard-to-reach' areas across the UK, which may improve equality of opportunity in those areas. In addition, we expect our decision will improve communications services for persons living and visiting rural areas. To the extent that UK citizens in need of special protection, persons with disabilities, or older persons have a greater need of emergency services, we expect our decision to improve outcomes by increasing the likelihood of an improved 999 service. We have not identified any adverse impacts on specific groups of persons that are likely to be affected in a different way to the general population.

Welsh language

A2.42 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).

A2.43 We do not consider our decision, and proposals have any impact on opportunities for persons to use the Welsh language or treating the Welsh language no less favourably than the English language. We also do not think there are ways in which our decision and proposals could be formulated so as to have, or increase, a positive impact, or not have adverse effects or decrease any adverse effects. This is because our decision and proposals relate to spectrum access across the UK.

A2.44 We note that Ofcom's current practice is to offer to produce spectrum licences in Welsh, and when requested does provide licences in Welsh, in accordance with its obligations set by the Welsh Language Commissioner. This will apply to licences discussed in this document.

[105] https://www.legislation.gov.uk/ukpga/1998/47/section/75
[106] Ofcom's Impact Assessment Guidance

A3. Calculation of PFD limits

A3.1 In this annex, we describe our approach for determining suitable limits on non-terrestrial network (NTN) D2D satellite transmissions for coexistence with terrestrial mobile services. These limits are defined in terms of the total power flux density (PFD) of a D2D satellite network at the surface of the earth.

A3.2 This annex is structured as follows:

- **Our proposed method** in which we describe the main inputs we consider in our analysis and how these inputs are used to calculate a PFD limit on D2D satellite emissions;
- **Coexistence with terrestrial mobile user equipment (UE)** in which we describe our assumptions for calculating a PFD limit for coexistence with mobile user equipment;
- **Coexistence with terrestrial mobile base stations (BS)** in which we describe our assumptions for calculating a PFD limit for coexistence with terrestrial mobile base stations; and
- **Comparison with cross-border coordination limits** in which we describe how the PFD limits we have calculated compare with the limits in our cross-border agreements with our neighbouring administrations.

Our proposed method

A3.3 In order to determine suitable values for protecting terrestrial mobile services operating in the adjacent block within the same geographical area and terrestrial mobile operating co-channel in border regions, we have adopted the approach presented in equation 1 (A3.6).

A3.4 This equation was adopted during the WRC-23 study cycle for defining PFD limits for coexistence between high altitude platforms as IMT base stations (HIBS)[107] and terrestrial mobile services. We consider that extending this analysis to define PFD limits for D2D satellite transmissions is appropriate because the geometry of the interference scenario is similar. We also note that the work currently in progress as part of AI 1.13 at ITU WP 5D for WRC-27 uses the WRC-23 HIBS analysis as its starting point.

A3.5 For a terrestrial mobile UE, the PFD levels obtainable using the method presented in equation 1 represents the **total interference limit** for all D2D satellite emissions from all visible angles measured in a 1 MHz bandwidth at the ground level. We use this method in A3.9-A3.12 to determine the PFD limits for protecting a terrestrial mobile UE.

A3.6 With respect to the terrestrial mobile BS, we used this equation to investigate how the PFD limit obtained from equation 1 varies with the BS antenna pattern.

$$PFD(\theta) = 10\log_{10}(kTB) + NF + \frac{I}{N} - G_r(\theta) + \mathrm{L} - 10\log_{10}\frac{\lambda^2}{4\pi} \quad (1)$$

[107] Chapter 4 - Annex 4.35 – Annex 4 - Sharing and compatibility studies of high-altitude platform stations as IMT base stations (HIBS) in 2 500-2 690 MHz frequency range, Page 7.

where:

k	is Boltzmann's constant (1.380649×10^{-23} J/K)
T	is the receiver noise temperature (Kelvin)
B	is the reference bandwidth (1 MHz)
NF	is the receiver noise figure (dB)
$\frac{I}{N}$	is the receiver interference to noise ratio limit (dB)
$G_r(\theta)$	is the effective antenna gain (dBi) of the receiver antenna towards the direction of the interferer
θ	is the elevation angle (°) towards the direction of the interferer
L	is the receiver antenna feeder loss for IMT BS (dB)
$10 \log_{10} \frac{\lambda^2}{4\pi}$	is the antenna aperture (dB.m^2) at the wavelength, λ (m).

Coexistence with terrestrial mobile user equipment

A3.7 In Table A3.1, we show the values and parameters used to determine the PFD limit using equation 1 for coexistence with a terrestrial mobile user equipment (UE) operating at the centre of the 900 MHz mobile downlink band, 942.5 MHz.

A3.8 In order to calculate the PFD limit for coexistence with terrestrial mobile UE, we have adopted most of the parameters in the IMT characteristics document (5D/716)[108] from ITU WP 5D. This document is recommended by ITU WP 5D for sharing and compatibility studies for the frequency ranges being considered for D2D transmissions.

[108] Chapter 4 - Annex 4.4 - Characteristics of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23

Table A3.1: Determining PFD limits for coexistence with terrestrial mobile UE (900 MHz band)

Terrestrial mobile (UE)		
Parameter	**Value**	**Comment**
Freq (MHz)	942.5	centre of the 900 MHz mobile downlink band
$\mathbf{10\log_{10}(kTB)}$ **(dBW/MHz)**	-144	Thermal noise density
$\boldsymbol{NF}$ **(dB)**	9	This is adopted from 5D/716[108], Table 1, page 3
$\mathbf{10\log_{10}(kTB) + NF}$ **(dBW/MHz)**	-135	UE noise floor density
$\frac{I}{N}$ **(dB)**	-6	This is adopted from 5D/716[108], Table 13, page 26
$\boldsymbol{G_r}$ **(dBi)**	-3	This is adopted from 5D/716[108], Table 5-2, page 12
$\mathbf{10\log_{10}\frac{\lambda^2}{4\pi}}$ **(dB.m²)**	-21	Antenna aperture
PFD limit (dBW/MHz/m²)	**-117**	Calculated using equation 1

A3.9 Our modelling considers that the UE antenna gain is uniform in all directions and so the PFD limit ($PFD(\theta)$) obtained using equation 1 is the same for all angle of arrivals, hence it is not elevation dependent.

A3.10 We have adopted:

a) –3 dBi for the UE antenna gain because this is in line with the terrestrial mobile UE characteristics provided in 5D/716[108].

b) 0 dBi for the UE body loss because this is consistent with a user who is using their phone for text and data services and so there may be no shielding of the UE by the user's body. We believe that this is a conservative assumption because other use cases might have significant body loss, for example, voice, where a user may be using their phone next to their head.

A3.11 The PFD limit calculated in Table A3.1 has been estimated at 942.5 MHz as an example and the same parameters have been used to calculate the PFD limit for all the bands considered for D2D in Table A3.2. The only exception to this is the antenna aperture term ($10\cdot\log_{10}(\lambda^2/4\pi)$) which is frequency dependent and so varies between mobile bands.

Table A3.2: Proposed PFD limits for coexistence with terrestrial mobile UE

Mobile Band	Mobile Downlink PFD Limit
MHz	*dBW / MHz / m²*
700	-119
800	-118
900	-117
1400	-113
1800	-111
2100	-109
2600	-108

Equivalent RSRP

A3.12 We do not normally use PFD limits when describing coverage in mobile networks. A more common terminology is Reference Signal Received Power ("RSRP"), so we have translated our PFD limits into the equivalent RSRP limit to allow for comparison. We note that this equivalent RSRP limit conversion assumes a noise-limited environment rather than interference-limited environment.

A3.13 We calculate the equivalent RSRP limit as follows:

$$P_R = 10\log_{10}(kTB) + NF + \frac{I}{N} - G_r(\theta) + \mathrm{L} \qquad (2)$$

where:

P_R	is the power limit at the UE antenna connector, equivalent to the PFD limit at the UE antenna (dBW / MHz).
other terms	have the same meaning as in equation 1.

A3.14 and

$$P_{RSRP} = P_R + 10 \cdot \log_{10}(1000) + 10 \cdot \log_{10}(15/1000) \qquad (3)$$

where:

P_{RSRP}	Is the equivalent RSRP limit assuming a noise-limited environment (dBm)
P_R	is the power limit at the UE antenna connector, equivalent to the PFD limit at the UE antenna (dBW / MHz).
$10 \cdot \log_{10}(1000)$	is the unit magnitude adjustment factor going from dBW to dBm (dB)

$10 \cdot \log_{10}(15/1000)$ is the bandwidth adjustment factor going from 1 MHz to the bandwidth of a single resource element, 15 kHz (dB)

A3.15 Using the values from Table A3.1 above, we get an equivalent RSRP limit of -126 dBm for all mobile bands (because RSRP, unlike PFD, does not have a frequency dependency). This is 6 dB below the minimum useable sensitivity commonly cited for mobile user equipment (-120 dBm RSRP).

Coexistence with terrestrial mobile base stations

A3.16 In order to determine the variation of the terrestrial mobile BS PFD limit with elevation angle (θ) towards an interfering satellite, we have adopted some of the parameters in 5D/716[108]. With respect to the terrestrial mobile BS noise figure and feeder loss, we have used values that are more representative of deployments in the field. These parameters are given in Table A3.3.

A3.17 Given that terrestrial mobile BS usually points below the horizon with down tilt, we have calculated the BS antenna gain towards an interfering satellite by taking down tilt into account. The BS antenna gain has been simulated for non-AAS BS using ITU-R F.1336 (kp = 0.7, kh = 0.7, kv = 0.3, φ_3= 65°, $\theta_3 = 7.5°$).

A3.18 The PFD limits for coexistence with terrestrial mobile base stations obtained for varying the elevation angles is given in Table A3.4. We note that varying the elevation angle only affects the terrestrial mobile BS gain ($G_r(\theta)$) towards the interferer.

Table A3.3: Parameters considered for determining PFD limits for protecting terrestrial mobile base stations

Terrestrial mobile (BS)		
Parameter	**Value**	**Comment**
$10\log_{10}(kTB)$ **(dBW/MHz)**	-144	Thermal noise density
NF**(dB)**	3	We believe this is representative for deployments in the field
$10\log_{10}(kTB) + NF$ **(dBW/MHz)**	-141	BS noise floor
$\frac{I}{N}$**(dB)**	-6	This is adopted from 5D/716[108], Table 13, page 26
G_{r_max} **(dBi)**	15	Peak non-AAS antenna gain. This is adopted from 5D/716[108], Table 4-1 for rural macro deployments below 1GHz
Downtilt (°)	3	Downtilt introduced to our implementation of ITU-R F.1336. From 5D/716[108] (Table 4-1, page 9 and Table 5-1, page 11). This downtilt value is recommended for rural macro deployments for up to 3GHz
L_Feeder loss(dB)	1	We believe this is representative for deployments in the field where remote radio heads are connected by fiber cables to the base band unit

Table A3.4: PFD limit variation per elevation angle for coexistence with a terrestrial mobile base station operating at 897.5 MHz (centre of the 900 MHz mobile uplink band). For comparison, the mobile downlink PFD limit from Table A3.2 is -117 dBW/MHz/m².

Elevation Angle (θ)	$G_r(\theta)$ (dBi)	Mobile Uplink PFD limit (dBW/MHz/m²)
0	13	-138
10	2	-127
20	0	-125
30	-2	-123
40	-4	-121
50	-5	-120
60	-7	-118
70	-8	-117
80	-9	-116

Elevation Angle (θ)	$G_r(\theta)$ (dBi)	Mobile Uplink PFD limit (dBW/MHz/m^2)
90	-10	-115

Comparison with cross-border coordination trigger thresholds

A3.19 D2D satellite transmissions in the UK will, in many cases, be co-channel with terrestrial mobile networks in countries and crown dependencies which are adjacent to the UK mainland area. We have therefore compared the PFD limits we obtained using equation 1 (A3.6) with the cross-border limits in memoranda of understanding ("MoUs") that the UK has signed with neighbouring countries[109] as shown in Table A3.5.

A3.20 We have considered the field strength coordination thresholds for non-preferential PCI codes in our MoUs which apply at the 3m above ground level at the victim border / coastline. We have not considered the field strength coordination thresholds for preferential PCI (Physical-layer Cell Identity) codes because the ECC Recommendations for the use of preferential PCI codes were developed considering terrestrial networks and typically apply up to 6 km inside the borders of a neighbouring country. Therefore, the preferential PCI code coordination trigger thresholds might not be appropriate for D2D satellite geometries. This is because there will be less terrain and clutter attenuation of the satellite transmissions arriving from high elevation angles into a victim mobile network than transmissions from terrestrial mobile networks arriving from the horizon.

A3.21 We note that the field strength coordination thresholds in our MoUs are all the same except for 2100 MHz where the limits are 10 dB more relaxed in the MoU between France and the Channel Islands[110] than in the MoUs between the main land area of the UK and France[111], the Republic of Ireland [112] and the Isle of Man.[113]

[109] International coordination, Last updated: 29 November 2024

[110] Page 4, Memorandum of understanding on frequency co-ordination between France and the United Kingdom of Great Britain and Northern Ireland concerning the spectrum coordination of land mobile radiocommunication networks in the frequency range 698 to 2690 MHz to be applied in the area of the Channel Islands and France, ANFR and Ofcom, 1 February 2025

[111] Page 5, Memorandum of understanding on frequency co-ordination between France and the United Kingdom of Great Britain and Northern Ireland concerning the spectrum coordination of land mobile radiocommunication networks in the frequency range 698 to 2690 MHz to be applied in the mainland area ANFR and Ofcom, 1 February 2025

[112] Table 6, Memorandum of understanding on frequency coordination between Ireland and the United Kingdom of Great Britain and Northern Ireland concerning the spectrum coordination of mobile/fixed communications networks in the frequency range 703 MHz to 43.5 GHz, ComReg and Ofcom, 1 November 2024

[113] Table 4, Coordination procedure between the Isle of Man and the United Kingdom concerning the spectrum coordination of mobile/fixed communications networks in the frequency range 703 MHz to 3800 MHz

A3.22 We note that the coordination thresholds provided MoUs are usually field strength values in dBµV/m per 5 MHz, hence we have converted the PFD limits obtained using equation 1 to field strength and applied a bandwidth correction factor as shown in equation 4.[114]

$$E = S + 145.8 + 10 \cdot \log_{10}(5) \quad (4)$$

where:

E	is the electric field strength (dBµV/m per 5 MHz)
S	is the power flux-density (dBW/m^2/MHz)
$10 \cdot \log_{10}(5)$	is the bandwidth correction factor (dB)

Table A3.5: Comparing our calculated PFD limits with the coordination thresholds in our MoUs with neighbouring administrations.

Mobile frequency band	PFD limit from eqn. 1 for coexistence with UEs	Equivalent field strength limit from eqn.2	Coordination threshold for the use of non-preferential PCI codes from MoUs	Difference
	dBW/MHz/m²	dBµV/m/5 MHz	dBµV/m/5 MHz mean field strength @ 3m agl at the victim border / coastline	dB
700	-119	34	41	7
800	-118	34	41	7
900	-117	36	41	5
1400	-113	40	41	1
1800	-111	42	47	5
2100 *France & CI MoU*	-110	43	47	4
2100 *France, RoI & IoM MoU*	-110	43	37	-6
2600	-108	45	47	2

A3.23 We observe that the PFD limits we have calculated are more conservative than the coordination thresholds used for cross-border coordination in all but one case. The one exception to this is in 2100 MHz where our calculated PFD limit is 6 dB more relaxed than the cross-border coordination threshold agreed with France, the Republic of Ireland and Isle of Man.

[114] This equation is adapted from ITU R-REC-P.525, equation 11

A4. Coexistence with users in spectrum adjacent to mobile bands

A4.1 In this annex we assess coexistence between new D2D space-to-Earth (s-E) satellite transmissions in mobile bands with incumbent services in adjacent spectrum. Our coexistence assessment follows the method described in *Coexistence with other adjacent band users* in Section 4 of this consultation. We provide a brief description of each service considered including typical use cases, deployment/mode of operation, and technical specifications.

Digital Terrestrial Television (DTT)

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
700	**Green**	Nationwide

A4.2 We considered both the discrimination of DTT antennas towards the sky and the large minimum frequency separation of DTT to new D2D satellite transmissions and we therefore believe that further coexistence studies are unlikely to be necessary.

Details of our assessment

A4.3 DTT is a nationwide service broadcast from masts across the UK operating in the 470-694 MHz band. DTT receivers are typically installed at fixed locations on the homes, businesses and other premises of TV watchers across the UK. DTT antennas are typically directional and installed pointing towards the horizon and so will have some rejection of interference coming from the sky.

A4.4 We observe that D2D satellite transmissions will be at a minimum frequency separation of 44 MHz from DTT services if the 700 MHz SDL band (738-758 MHz) is used for D2D. The maximum transmission bandwidth that could be used for D2D in the 700 MHz SDL band is 20 MHz (because there is only 20 MHz available in 738-758 MHz), so DTT would always be in the spurious domain of D2D satellite transmissions and therefore the risk of interference will be very low.

Programme Making and Special Events (PMSE)

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
700, 800, 900, 1400, 1800, 2100	**Green**	Nationwide

A4.5 We note that PMSE use cases tend to be short range and use omnidirectional antennas or directional antennas with discrimination towards the sky. We therefore believe that further coexistence studies are unlikely to be necessary to demonstrate coexistence with new D2D satellite transmissions.

Details of our assessment

A4.6 PMSE uses several bands which are close in frequency to those that could be used for D2D satellite transmissions. In the 1400 MHz band, PMSE use is only permitted for special occasions. There are no PMSE authorisations in spectrum adjacent to the 2600 MHz paired mobile band.

A4.7 For our coexistence assessment, we focused on the most common use cases in the relevant frequency bands. There are various PMSE use cases such as audio, comms and talk back, audio distribution, telemetry, video and camera links, and we believe wireless audio and video are typical examples for these deployments. We note that wireless audio related services are mostly deployed below the 700 MHz band, with video and camera links mostly deployed in the lower 2 GHz range.

A4.8 In assessing the interference risk to PMSE from adjacent D2D satellite transmissions, we note that this service already operates in challenging interference environments with some deployments occurring within terrestrial mobile guard bands as well as the TV whitespace band.

GSM-Rail

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
900	**Green**	Nationwide

A4.9 We consider that GSM-R terminals are not more sensitive to interference from new D2D satellite transmissions than a terrestrial mobile UE and therefore believe that no additional coexistence studies are likely to be needed.

Details of our assessment

A4.10 GSM-R is an international wireless communications standard for railway communication and applications deployed on trains and railway infrastructure in the UK. The GSM-R downlink (921-925 MHz) is immediately adjacent to spectrum which could be used for new D2D satellite transmissions at 900MHz (925-960 MHz).

A4.11 For this service we considered handheld, and train mounted receivers which we note have similar noise figures[115] and antenna characteristics as a terrestrial network mobile UEs. We therefore consider that these devices are not more sensitive to interference from new D2D satellite transmissions than a terrestrial network mobile UE.

[115] ECC Report 96 page 8

A4.12 We note that the in-band power levels for D2D satellite transmissions will be much lower than those of terrestrial mobile base stations and therefore we consider there will be no risk of receiver blocking.

Aeronautical Navigation Aid Stations

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
900	**Green**	Nationwide

A4.13 For this service we considered distance measurement equipment (DME)/area navigation-RNAV[116]. We note that this service has two segments: the down pointing antennas on the aircraft and a ground segment at specific locations. We consider that for both segments of this service, it is unlikely that further coexistence studies are necessary.

Detail of our assessment

A4.14 Radio navigation technique can be used to provide a slant distance when a DME (on an aircraft) is used with a DME transponder on the ground. This service can also be used to provide two-dimensional navigation if the DME transponder on the ground is integrated with a Doppler VHF omnidirectional range (DVOR). This service operates in the 960 -1215 MHz band. From the UK spectrum map[117], aeronautical use considered within our risk assessment is aeronautical navigation aid stations.

A4.15 The DME antennas on the aircraft are below the fuselage and down pointing towards the ground stations on earth. Hence the aircraft's fuselage provides some shielding from D2D s-E transmissions.

A4.16 There are nineteen ground based VOR beacons in the UK[118] with sites co-located with a DME transponder retained as a safety back up for aircraft navigation in case of satellite navigation failure.[119] For these DME transponders and associated DVOR on the ground, we consider that they are omnidirectional antennas with low gain, hence we believe that no additional coexistence studies are likely to be needed.

MOD

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
900	**Green**	Nationwide
1400	**Amber**	Nationwide

[116] https://www.ofcom.org.uk/spectrum/radio-equipment/licence-products/
[117] https://static.ofcom.org.uk/static/spectrum/map.html#
[118] https://www.caa.co.uk/publication/download/18864, Page 6, 12
[119] https://nats.aero/blog/2015/05/has-gps-killed-off-the-vor/ accessed 17 February 2025

A4.17 MOD uses systems in spectrum in the adjacent to 900 and 1400 MHz mobile bands. MOD systems in spectrum adjacent to the 1400 MHz mobile band could use high gain antennas with elevation towards the sky and so might be more susceptible to interference from D2D satellite transmissions than mobile. We are not aware of MOD systems using high gain antennas in spectrum adjacent to the 900 MHz mobile band.

Detail of our assessment

A4.18 MOD uses include aeronautical communications links[120] and aeronautical navigation systems[121] in 960-1215 MHz. We believe that these systems might typically use low gain antennas and so are unlikely to be significantly more susceptible to interference from D2D satellite transmissions than mobile.

A4.19 MOD uses systems in 1427-1452 MHz, that are used both at fixed locations with installed equipment and at temporary locations with transportable equipment. These systems could use high-gain antennas with elevation towards the sky and so might be more susceptible to interference from D2D satellite transmissions than mobile.

Mobile Satellite Service (MSS)

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
1400, 2100	**Green**	Nationwide

A4.20 We consider that new D2D satellite transmissions are likely to have similar characteristics to incumbent MSS services. We therefore believe that new D2D satellite transmissions will not materially change the interference environment for incumbent MSS services. We therefore consider that no additional coexistence studies are likely to be needed to ensure coexistence with MSS.

Detail of our assessment

A4.21 Typical MSS use cover land mobile, maritime and aeronautical. For these use cases, we note that there is MSS s-E spectrum at L-band (1518 – 1559 MHz) and S-band (2170 – 2200 MHz). These bands are close in frequency to the 1400 and 2100 MHz mobile downlink bands respectively.

Radioastronomy Service (RAS)

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
1400, 2600	**Amber**	Local

[120] Including, for example, Link 16
[121] Including, for example, TACAN

A4.22 The radioastronomy service is very sensitive to satellite transmissions. Further detailed modelling is likely to be necessary to demonstrate whether D2D satellites can coexist with radioastronomy when providing a D2D service using 1400 or 2600 MHz in areas near radioastronomy sites. There are six radioastronomy sites with Recognised Spectrum Access in the UK and coexistence may be possible when providing a D2D service in areas far from these sites.

Detail of our assessment

A4.23 The radioastronomy service observes and measures phenomena that are very far away from the Earth. The emissions from these phenomena are typically very weak when they reach the Earth, so large, high gain antennas pointing towards the sky are necessary to detect them. These characteristics make the service sensitive to interference, particularly interference coming from the sky.

A4.24 The RAS in the UK uses several frequencies at several locations and Ofcom notes these uses in its grants of Recognised Spectrum Access ("RSA") to the RAS. In the UK, we have granted RSA to the RAS at six sites in two bands which are close in frequency to mobile bands.

Table A4.1: Radioastronomy sites with grants of RSA in 1400-1427 MHz and 2690-2700 MHz

Site Name	Recognised location of wireless telegraphy use *National Grid Reference (NGR)*
Jodrell Bank	SJ 79650 70950
Cambridge	TL 39400 54000
Darnhall	SJ 64275 62265
Defford	SO 90200 44700
Knockin	SJ 32855 21880
Pickmere	SJ 70404 76945

A4.25 There are several ITU Recommendations relevant to assessing coexistence between NGSO satellite transmissions and radioastronomy. The Recommendations that are relevant for D2D satellite transmissions are: ITU-R S.1586,[122] ITU-R RA.769[123] and ITU-R RA.1513.[124]

A4.26 Given the sensitivity to interference of these radioastronomy sites, it may not be possible to provide a D2D service near a radioastronomy site when using the 1400 MHz or 2600 MHz mobile bands for D2D satellite transmissions.

[122] Calculation of unwanted emission levels produced by a non-geostationary fixed-satellite service system at radio astronomy sites, ITU-R S.1586, January 2007
[123] Protection criteria used for radio astronomical measurements, ITU-R RA.769, May 2003
[124] Levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service on a primary basis , ITU-R RA.1513, March 2015

Space Science (Excluding RAS)

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
1400, 2600	**Green**	Nationwide

A4.27 Space science (excluding RAS) uses 1400-1427 MHz and 2690-2700 MHz. We consider that the risk of interference to space science is low.

Detail of our assessment

A4.28 We considered space science uses including the space research service (SRS), space operations service (SoS) and earth exploration satellite service (EESS).

A4.29 We note that the 1400-1427 MHz band is core to Space Science. EESS (passive) sensors operate in the 1400-1427 MHz band and they measure soil moisture, sea-surface salinity and vegetation biomass.[125] EESS (passive) sensors operate on satellites so any potential interference path from new D2D satellite transmissions in 1452-1492 MHz would be satellite-to-satellite and we would expect this risk of interference to be managed by the filing administration.

A4.30 We are not aware of EESS use in the 2690-2700 MHz band within the UK and are also not aware of any SRS and SoS missions in either the 1400-1427 MHz or the 2690-2700 MHz bands within the UK. We therefore consider that there will be no risk of interference from new D2D satellite transmissions to these services.

European aviation network (EAN)

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
2100	**Green**	Nationwide

A4.31 We note that there is a mobile satellite service ("MSS") allocation in 2170– 2200 MHz and we consider that new D2D s-E transmissions will not materially change the interference environment. We therefore consider that no additional coexistence studies are likely to be needed to ensure coexistence with EAN.

[125] Considering (e), ITU-R Resolution 750 (REV.WRC-19)

Details of our assessment

A4.32 The EAN provides connectivity for aircraft flying across Europe from ground-based stations. In 2017, we authorised Inmarsat's EAN system.[126] In this assessment we consider the following relevant segments of the EAN:

a) The GSO satellite -> satellite terminal operating in the 2170 – 2185 MHz range.

b) The complementary ground component (CGC) -> ground-facing terminal operating in the 2170 – 2185 MHz range.

A4.33 When considering the GSO satellite -> satellite terminal segment of the EAN, we note that this segment already operates within the MSS s-E direction (2170 – 2200 MHz) and we believe that new D2D s-E transmissions in 2110-2170 MHz will have similar transmission characteristics to MSS. Therefore, we believe that new D2D s-E transmissions will not significantly change the interference environment.

A4.34 When considering the complementary ground component (CGC) -> ground-facing terminal segment, we note that the antenna on the aircraft is pointing down towards the earth. Since the antenna is below the fuselage of the aircraft, the fuselage will provide some shielding from D2D s-E transmissions.

Satellite Earth Stations for Telemetry Tracking and Command

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
2100	**Green**	Nationwide

A4.35 We note that there is a mobile satellite service ("MSS") allocation in 2170 – 2200 MHz and we consider that new D2D s-E transmissions in 2110-2170 MHz will not materially change the interference environment. We therefore consider that no additional coexistence studies are likely to be needed to ensure coexistence with satellite earth stations for telemetry tracking and command.

Details of our assessment

A4.36 For this service, we have considered telemetry tracking and command (TT&C) operating in the 2200 – 2290 MHz band for earth stations (in the s-E direction) for non-geostationary orbits (NGSO) satellites, spaceports and space science uses like EESS, SRS.

A4.37 We note that this service already operates within the MSS s-E direction (2170 – 2200 MHz), hence we consider the risk to be low as the service already operates in a similar interference geometry (when compared to MSS s-E transmissions).

[126] https://www.ofcom.org.uk/siteassets/resources/documents/consultations/uncategorised/7815-2ghz-mobile-satellite-systems/inmarsat-mobile-satellite-services.pdf?v=322749. The spectrum licence to operate the EAN in the UK is due to expire in May 2027.

Military and Civil ATC Radars

Coexistence assessment

Relevant mobile bands	*Coexistence Assessment*	*Geographical extent*
2600	**Amber**	Local

A4.41 2.7-3.1 GHz radars could be susceptible to interference from D2D satellite transmissions. Further detailed study is likely to be necessary to demonstrate whether D2D satellites can coexist with 2.7-3.1 GHz radars when providing a D2D service using 2600 MHz in areas near Protected Radar sites. There are 77 Protected Radar sites in the UK and additional coexistence mitigations may be required in these areas.

Detail of our assessment

A4.42 The civil and military radar systems operating in 2700-3100 MHz are mainly used for air-traffic control ("ATC") and include safety of life applications.[127] These systems are typically used at fixed locations and use high gain antennas[128] pointing above the horizon and towards the sky.[129] This means that this service could be particularly sensitive to interference coming from the sky.

A4.43 MNOs must coordinate their 2.6 GHz terrestrial mobile network deployments with 2.7-3.1 GHz radars.[130] The radars that MNOs must coordinate with are on the Protected Radars List.[131]

A4.44 Coexistence between terrestrial mobile networks and ATC radar is considered in ECC Report 174.[132] We note that we decided not to permit unmanned aircraft systems ("UAS") to use 2.6 GHz in order to protect ATC radar.[133] Further study would be required to understand the risk of interference from D2D satellite transmissions in 2.6 GHz to ATC radar.

[127] Paragraph 4.34, Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues, 22 March 2011
[128] Typically 34 dBi in the main beam direction, Paragraph 2.14, Coordination procedure for air traffic control radar - notice issued to 2.6 GHz Licensees, Ofcom, 27 September 2023
[129] Minimum elevation angle of 2°, Table 5, Harmonised compatibility and sharing conditions for video PMSE in the 2.7-2.9 GHz frequency band, taking into account radar use, CEPT Report 61, 17 June 2016
[130] Coordination procedure for air traffic control radar - notice issued to 2.6 GHz Licensees, Ofcom, 27 September 2023
[131] Protected Radar list, Ofcom, 2 August 2024
[132] Compatibility between the mobile service in the band 2500-2690 MHz and the radiodetermination service in the band 2700-2900 MHz, ECC Report 174, 11 April 2012
[133] Paragraph 1.12, STATEMENT: Spectrum for Unmanned Aircraft Systems (UAS), Ofcom, 16 December 2022.

A5. Local Access and Offshore Network Licences

A5.1 In this annex we describe Ofcom's Local Access and Offshore Network licences, presenting data[134] on:

a) The number of active Local Access Licences per frequency band;

b) The number of active Offshore Network Licences per frequency band (as of February 2025); and

c) The number of active Offshore Network locations (base station deployments) per frequency band.

A5.2 We consider it appropriate to show both the number of Offshore Network locations (base station deployments) and number of active licences as it better reflects the deployment reality.

A5.3 As set out in Section 6, we are proposing to require licensees to meet the power limits for protecting other mobile networks, in locations where Ofcom has issued co-channel Local Access or Offshore Network licences. These limits can only be exceeded if coordination agreements are reached with impacted licence holders.

Local Access Licences

A5.4 A Local Access Licence is a mechanism that enables the shared use of spectrum which is already licensed on a national basis to mobile network operators (MNOs), in locations where a particular frequency is not being used.

A5.5 The default licence period is three years. However, in some cases, it may be desirable, and possible, to negotiate (through agreement with the existing licensee) a longer-term licence. In those cases, we would issue the licence for the agreed period.

A5.6 We have looked at where Local Access Licences have been awarded and the spectrum used to give stakeholders an indication of locations where protection will be required.

Table A5.1: Number of Local Access Licences per frequency band

Frequency band (MHz)	Number of active Local Access Licences (as of February 2025)
700 MHz	0
800 MHz	0
900 MHz	0
1.4 GHz	0

[134] Data is accurate as of 28 February 2025.

Frequency band (MHz)	Number of active Local Access Licences (as of February 2025)
1800 MHz	11
2.1 GHz	0
2.3 GHz	0
2.6 GHz	12

Offshore Network Licences

A5.7 Ofcom issues Offshore Network licences to enable communication on offshore platforms, such as oil and gas rigs and windfarms, largely in the North Sea. These licences are ongoing licences, renewable every five years.

A5.8 We have looked at where Offshore Network licences have been awarded and the spectrum used to provide stakeholders with information on locations where protection will be required.

Table A5.2: Number of active Offshore Network licences per frequency band (MHz)

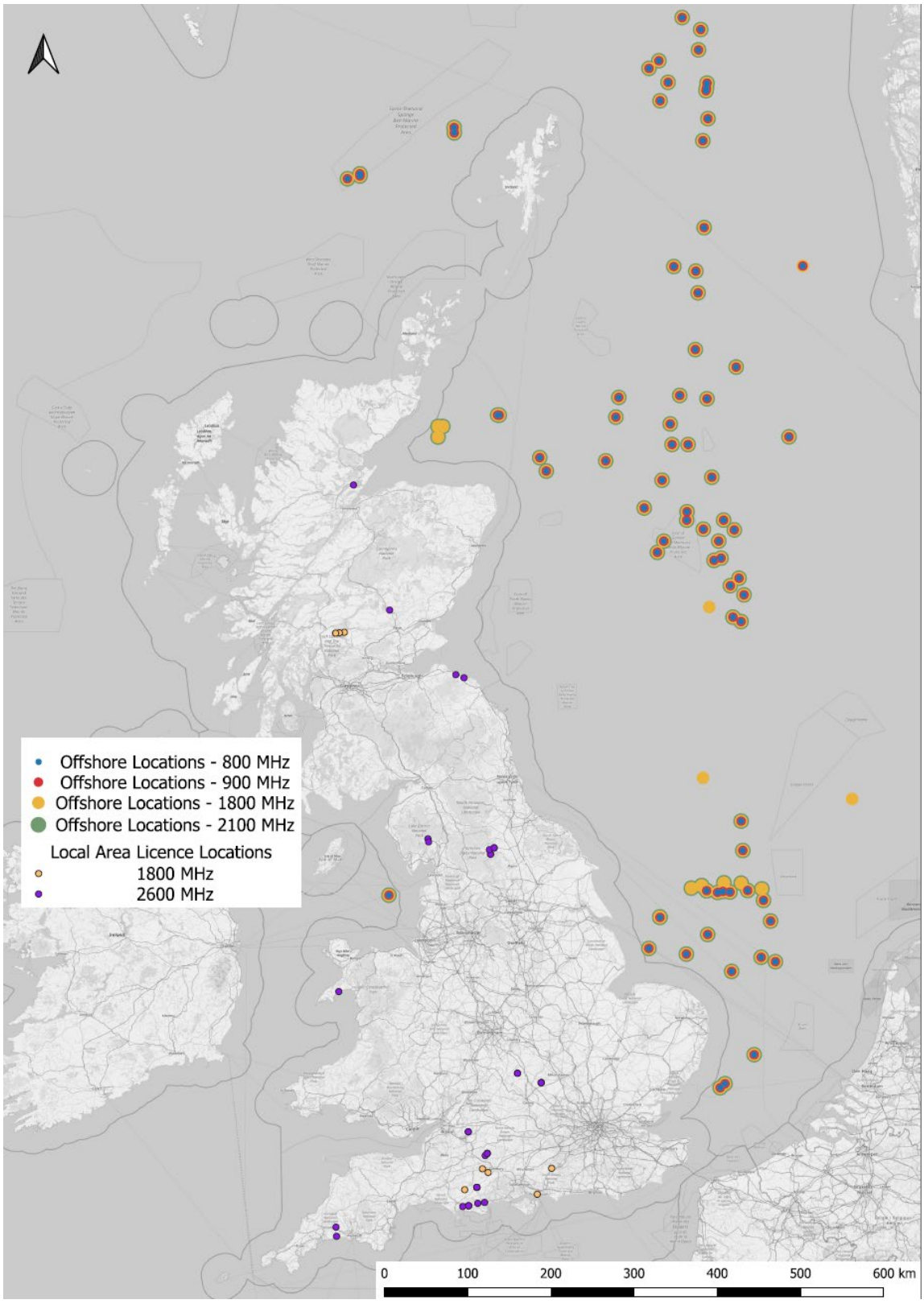
Frequency Band	Number of active Offshore Mobile Network Licences per band (as of February 2025)
700 MHz	2
800 MHz	3
900 MHz	4
1.4 GHz	0
1800 MHz	9
2.1 GHz	5
2.3 GHz	0
2.6 GHz	1

Table A5.3: Number of locations of Offshore Network licence deployments per frequency band (MHz)

Frequency band	Number of Offshore Network locations frequency band is deployed, out of a total of 96 locations (as of February 2025)
700 MHz	2

Frequency band	Number of Offshore Network locations frequency band is deployed, out of a total of 96 locations (as of February 2025)
800 MHz	75
800 MHz	75
1.4 GHz	9
1800 MHz	89
2.1 GHz	85

Figure A5.1: Map showing locations of Local Access and Offshore Network deployments[135]



[135] The data shown in this map is accurate as of 28 February 2025. We have published a high-resolution PDF version of this map separately.

A6. Responding to this consultation

How to respond

A6.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 20 May 2025.

A6.2 You can download a response form from https://www.ofcom.org.uk/spectrum/space-and-satellites/consultation-enabling-satellite-direct-to-device-services-in-mobile-spectrum-bands/. You can return this by email or post to the address provided in the response form.

A6.3 If your response is a large file, or has supporting charts, tables or other data, please email it to mobilefromskyandspace@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet. This email address is for this consultation only and will not be valid after 20 May 2025.

A6.4 Responses may alternatively be posted to the address below, marked with the title of the consultation:

Direct to Device project team
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A6.5 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.

A6.6 We will publish a transcript of any audio or video responses we receive (unless your response is confidential)

A6.7 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.

A6.8 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.

A6.9 It would be helpful if your response could include direct answers to the questions asked in the consultation document. The questions are listed at Annex A9. 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.

A6.10 If you want to discuss the issues and questions raised in this consultation, please contact the team by email at mobilefromskyandspace@ofcom.org.uk.

Confidentiality

A6.11 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.

A6.12 If you think your response should be kept confidential, please specify which part(s) this applies to and explain why. Please send any confidential sections as a separate annex. If you want your name, address, other contact details or job title to remain confidential, please provide them only in the cover sheet, so that we don't have to edit your response.

A6.13 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and try to respect it. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A6.14 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.

A6.15 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

A6.16 Following this consultation period, Ofcom plans to publish a statement in Q4 2025. If you wish, you can register to receive mail updates alerting you to new Ofcom publications.

Ofcom's consultation processes

A6.17 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex A7.

A6.18 If you have any comments or suggestions on how we manage our consultations, please email us at consult@ofcom.org.uk. We particularly welcome ideas on how Ofcom could more effectively seek the views of groups or individuals, such as small businesses and residential consumers, who are less likely to give their opinions through a formal consultation.

A6.19 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact the corporation secretary:

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

A7. Ofcom's consultation principles

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.

A8. Consultation coversheet

Basic details

Consultation title: Enabling Satellite Direct to Device services in Mobile spectrum bands

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)

A9. Consultation questions

Question 1: Do you agree with our assessment of the business models that could potentially emerge?

Question 1(a): Are there any other business models that you think could deliver benefits for people and businesses in the UK?

Question 1(b): Are there any business models that could not operate under our proposed approaches?

Question 2: Do you agree with our assessment of the benefits that could be realised through authorisation of D2D services?

Question 2(a): Are there any other benefits for UK citizens and businesses that could be realised?

Question 3: Do you have comments on how emerging D2D technology should support 999 service provision?

Question 4: Are there any mobile spectrum bands not in scope of our proposals that you think we should consider?

Question 5: Does deployment in supplementary downlink spectrum (SDL) present any challenges in comparison to other bands? Is there interest in deploying in this spectrum?

Question 6: Do you agree with our proposal to limit this authorisation to the UK mainland and territorial waters? If not, please explain why.

Question 7: Do you agree that our proposed technical conditions for D2D satellite emissions will protect mobile services delivered by other operators in adjacent areas and in adjacent spectrum?

Question 8: Do you agree with out high-level co-existence assessment for other services in adjacent spectrum to D2D?

Question 9: Are there other services co-channel or in adjacent spectrum that you think we should take into account when assessing coexistence? If so, please provide evidence of the nature of interference and what level of protection you consider is necessary.

Question 10: Do you agree with our preferred authorisation approach (option 2)? If not, please set out your reasoning.

Question 11: Are there any alternative authorisation options, not discussed here, that you believe are worth considering?

Question 12: Do you agree with the proposed conditions?

Question 13: Do you have any other comments on the proposals set out in this document?