Authorisation of terrestrial mobile networks complementary to 2 GHz Mobile Satellite Service (MSS)

A consultation on the licensing of 2 GHz MSS Complementary Ground Component (CGC) for aeronautical use

Consultation

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About this document

This document consults on proposals to authorise terrestrial base stations which allow ‘direct air-to-ground’ mobile satellite service (MSS) communications to aircraft.

MSS are communications satellites, intended for use with mobile and portable wireless communications for terrestrial, maritime and aeronautical service.

This consultation looks at the authorisation of these base stations, which form one end of the direct air-to-ground based links. .

This work follows plans from Inmarsat to use spectrum in the 2 GHz band to provide broadband services to passengers on aircraft. The company plans to do this through a combination of satellite and ground based communication links to aircraft.

Inmarsat is one of two companies awarded MSS spectrum access rights in 2009, in the 2 GHz band, under an EU-led pan-European harmonised selection and award process.

Contents

Section 1

Executive Summary

1.1 Inmarsat Ventures Limited (Inmarsat) is one of two companies[1] that were awarded Mobile Satellite Services (MSS) spectrum, in the 2 GHz band, under an EU-led pan-European selection and authorisation process. We refer to these companies as the "2 GHz MSS operators".

1.2 Inmarsat has expressed the wish to use this radio spectrum band to provide broadband services to passengers on aircraft. It plans to do this through a combination of satellite and ground based communication (DA2G) links to the aircraft.

1.3 The use of the spectrum in a complementary ground based network was anticipated in the EU award process and termed "Complementary Ground Component (CGC)".

1.4 In 2009, we consulted [2] on the terms of a wireless telegraphy licence, which would permit the use of this radio spectrum band by a CGC network (the "Spectrum Access 2GHz Licence"). In 2009, there were no concrete plans for the type of service that CGC might support. However, the CGC licence conditions were designed for a service provided to terrestrial users. Inmarsat is now proposing to develop and roll out the ground based CGC of the MSS system to support a mobile broadband service to aircraft - as part of a combined satellite and terrestrial system.

1.5 In this context, this document consults on a new and additional CGC Licence in order to authorise the DA2G base stations within the proposed aeronautical service. It also:

- explains how Inmarsat's combined satellite and terrestrial system is planned to operate;
- sets out how each of the individual radio elements needed to deliver the service are, or will be, authorised; and
- considers the consistency of Inmarsat's planned use of the spectrum with the EU legal framework

1.6 For this additional CGC Licence we propose to adapt the conditions contained in the Spectrum Access 2 GHz Licence in the following three ways:

- revise the format of the Licence from a UK-wide Spectrum Access Licence, to a Network Licence authorising use at specific locations identified in the Licence Schedule (and we refer to this as a "Network 2 GHz Access" licence accordingly);
- revise the technical conditions to ensure compatibility with existing and planned users in the same and adjacent bands; and

[1] The other company is EchoStar Mobile Limited (EchoStar) (formerly Solaris Mobile Limited (Solaris)).
[2] http://stakeholders.ofcom.org.uk/consultations/cgcs2/statement/

- revise the fees in a way that provides an incentive to locate base stations away from highly populated areas.

1.7 We propose to include technical conditions in the licence that take into account compatibility studies undertaken by CEPT[3] to safeguard adjacent users, both in-band and adjacent, from harmful interference.

1.8 We propose to base the fees on the UK-wide fee applicable to the Spectrum Access 2 GHz Licence of £554,000 per 2 x 1 MHz per annum. However, for this Network 2 GHz Licence we propose the fee to be based on a charge per individual base station, dependent on its location that will range from £825 to £64,000 per 2x 1 MHz per base station per annum, depending on the population density at the location of the base station.

1.9 We propose that this Licence only becomes available to the 2 GHz MSS operators following the:

- successful launch of their MSS satellite; [4] and

- conclusion of the consultation we will need to hold on the authorisation of the terminals on the aircraft themselves.

1.10 The Spectrum Access 2 GHz Licence referred to above will continue to be available to either 2 GHz MSS operator (to enable them to deploy, for example, a terrestrial mobile service). However, we propose that the same condition is adopted as for the Network 2 GHz Licence, namely that it will only be available to a 2 GHz operator once its MSS satellite is launched successfully.[5]

[3] http://www.ecodocdb.dk/doks/relation.aspx?docid=2561
[4] And subject to the conclusion of the current enforcement action
[5] And subject to the conclusion of the current enforcement action

Section 2

Introduction

2.1 Inmarsat is one of two companies[6] selected by the European Commission in 2009 as operators of Mobile Satellite Services (MSS) systems, in the 2 GHz band, under an EU pan-European selection and authorisation process. We refer to these companies as the "2 GHz MSS operators".

2.2 Inmarsat has expressed the wish to use this radio spectrum band to provide broadband services to passengers on aircraft. It plans to do this through a combination of satellite and ground based communications links to the aircraft.

2.3 The use of the spectrum in a complementary ground based network was anticipated in the EU award process and termed "Complementary Ground Component (CGC)".

2.4 In 2009, following consultation, we made a Statement[7] on the terms of a wireless telegraphy licence which would permit the use of this radio spectrum band by a CGC network ("the Spectrum Access 2 GHz Licence"). In 2009, there were no concrete plans for the type of service that CGC might support. However, the CGC licence conditions were designed for a service provided to terrestrial users.

2.5 Inmarsat is now proposing to develop and roll out the ground based CGC of the MSS system to support a mobile broadband service to aircraft - as part of a combined satellite and terrestrial system. Inmarsat has, therefore, requested that Ofcom review the authorisation regime for the CGC component in light of these plans.

2.6 We understand that Inmarsat's CGC network is intended to be similar in purpose to the Direct Air to Ground (DA2G) networks which provide broadband service to aircraft in US and which have been discussed in Europe. We therefore use the term DA2G to refer to the terrestrial component of the combined satellite and terrestrial system.

2.7 In this context, this document considers the development of a new and additional Licence to authorise CGC base stations for this DA2G use. In particular, we:

i) provide the legal framework for 2 GHz MSS and CGC;

ii) provide an overview of Inmarsat's planned aeronautical system;

iii) explain the authorisations required for the different radio elements of the planned aeronautical system;

iv) consider the consistency of Inmarsat's planned use of the spectrum and the EU legal framework;

v) propose how we will licence the CGC base stations (including technical conditions which take into account CEPT compatibility studies and are consistent with these compatibility studies);

[6] The other company is EchoStar (formerly Solaris).
[7] http://stakeholders.ofcom.org.uk/consultations/cgcs2/statement/

vi) propose spectrum fees for this new form of CGC Licence; and

vii) outline our planned next steps.

2.8 Whilst we describe and discuss the whole MSS system in this document, we are consulting at this time only on the authorisation of the CGC base stations. Other authorisations will be required for the terminals installed on the aircraft, and these will be the subject of a separate consultation processes later in 2016. We explain how all radio equipment required to deliver the service are, or will be, authorised in Section 5.

2.9 We plan to make this new licence available to both Inmarsat and EchoStar. Therefore in this document we refer to the entire frequency bands made available to 2 GHz MSS CGC. Each company, however, would only be able to apply for a licence that covers the frequencies it is authorised to use (i.e. Inmarsat could apply for a licence in respect of the frequencies 2170 to 2185 MHz and EchoStar could apply for a licence in respect of in respect of the frequencies 2185 to 2200 MHz). In addition, both companies will be able to apply for the Spectrum Access 2 GHz Licence, the terms of which were set out in our 2009 CGC Statement.

Impact Assessment

2.10 The analysis presented in this document represents an impact assessment, as defined in section 7 of the Communications Act 2003 (the Act).

2.11 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making. This is reflected in section 7 of the Act, which means that generally we have to carry out impact assessments where our proposals would be likely to have a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities. However, as a matter of policy Ofcom is committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. For further information about our approach to impact assessments, see the guidelines, Better policy-making: Ofcom's approach to impact assessment, which are on our website: http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf

Section 3

Legal Framework for 2 GHz MSS and CGC

3.1 MSS are radio communication services provided by an electronic communications network between a mobile earth station and one or more space stations, or between mobile earth stations by means of one or more space stations.

3.2 According to Recital 3 of Decision 2007/98/EC[8] systems capable of providing MSS *"are seen as an innovative alternative platform able to provide various types of pan-European telecommunications and broadcasting/multicasting services regardless of the location of end users, such as high speed internet/intranet access, mobile multimedia and public protection and disaster relief. These services could improve coverage of rural areas in the Community, thus bridging the digital divide in terms of geography. The introduction of new systems providing MSS would potentially contribute to the development of the internal market and enhance competition by increasing the offering and availability of pan-European services and end-to-end connectivity as well as encouraging efficient investments."*

3.3 Therefore, the European Commission decided to harmonise the conditions for the availability and efficient use of the frequency bands 1980 to 2010 MHz (earth-to-space) and 2170 to 2200 MHz (space-to-earth) for systems providing MSS.[9]

3.4 The harmonised EU approach is contained in a number of Decisions addressed to, and therefore binding on, Member States. The UK implemented the EU Decisions via The Authorisation of Frequency Use for the Provision of Mobile Satellites Services (European Union) Regulations 2010, as amended (the "Regulations").

3.5 In one of these EU Decisions, Decision 2009/449/EC[10], the European Commission selected Inmarsat and Solaris (now EchoStar) as the 2 GHz MSS operators and required Member States to authorise these operators to provide MSS and CGC in their jurisdiction.

3.6 Inmarsat was duly authorised, in respect of the United Kingdom, by Ofcom on 31 August 2010, authorisation reference 0828371/1, ("Inmarsat's Authorisation").[11] Inmarsat's Authorisation authorises Inmarsat to transmit and receive from a space station(s) operating within the frequency bands 1980 to 1995MHz for earth to space communications and 2170 to 2185 MHz for space to earth communications. Inmarsat's Authorisation was granted for a period of eighteen years with effect from 14 May 2009.

[8] Decision 2007/98/EC means Commission Decision of 14 February 2007 on the harmonised use of radio spectrum in the 2 GHz frequency bands for the implementation of systems providing mobile satellite services. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:043:0032:0034:EN:PDF

[9] Article 1 of the Decision 2007/98/EC.

[10] Decision 2009/449/EC means Commission Decision of 13 May 2009 on the selection of operators of pan-European systems providing mobile satellite services (MSS). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:149:0065:0068:EN:PDF

[11] Solaris (now EchoStar) was granted its authorisation on the same date.

3.7 Regulation 13(2) of the Regulations requires Ofcom, pursuant to our powers under the Wireless Telegraphy Act 2006, to grant to the MSS operators, if requested, the authorisation necessary for the provision of CGC of systems providing MSS. Such authorisation must be subject to the common conditions specified in Article 8(3) of Decision 626/2008/EC.[12]

3.8 We consulted, and concluded, on a regulatory framework for CGC in 2009 based on the information we had at that time (the "2009 statement"[13]). This took the form of a "Spectrum Access 2 GHz Licence". It included a set of technical and non-technical conditions that would permit the use of CGC for any technology complying with the block edge masks set out in the licence (including, for example, terrestrial mobile services). It also set out associated fee levels.[14] Inmarsat has since decided it wishes to use the spectrum to provide broadband services to aircraft (which we refer to as "aeronautical broadband"). The components of this service are described in the next section.

3.9 We note, however, that since winning the rights to use the spectrum neither of the 2 GHz MSS operators (Inmarsat or Solaris / EchoStar) has completed the required milestones in the prescribed time. As a result, the UK is bringing enforcement action against both operators in line with the EU Decision 2011/667/EU [15] as implemented in the UK by the Regulations.

[12] Decision 626/2008/EC which means Decision No. 626/2008/EC of the European Parliament and of the Council of 30 June 2008 on the selection and authorisation of systems providing mobile satellite services (MSS). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:172:0015:0024:en:PDF

[13] http://stakeholders.ofcom.org.uk/consultations/cgcs2/statement/

[14] To date neither operator has applied for this Licence

[15] Decision 2011/667/EU means Commission Decision of 10 October 2011 on modalities for coordinated application of the rules on enforcement with regard to mobile satellite services (MSS) pursuant to Article 9(3) of Decision No 626/2008/EC of the European Parliament and of the Council. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011D0667&from=EN

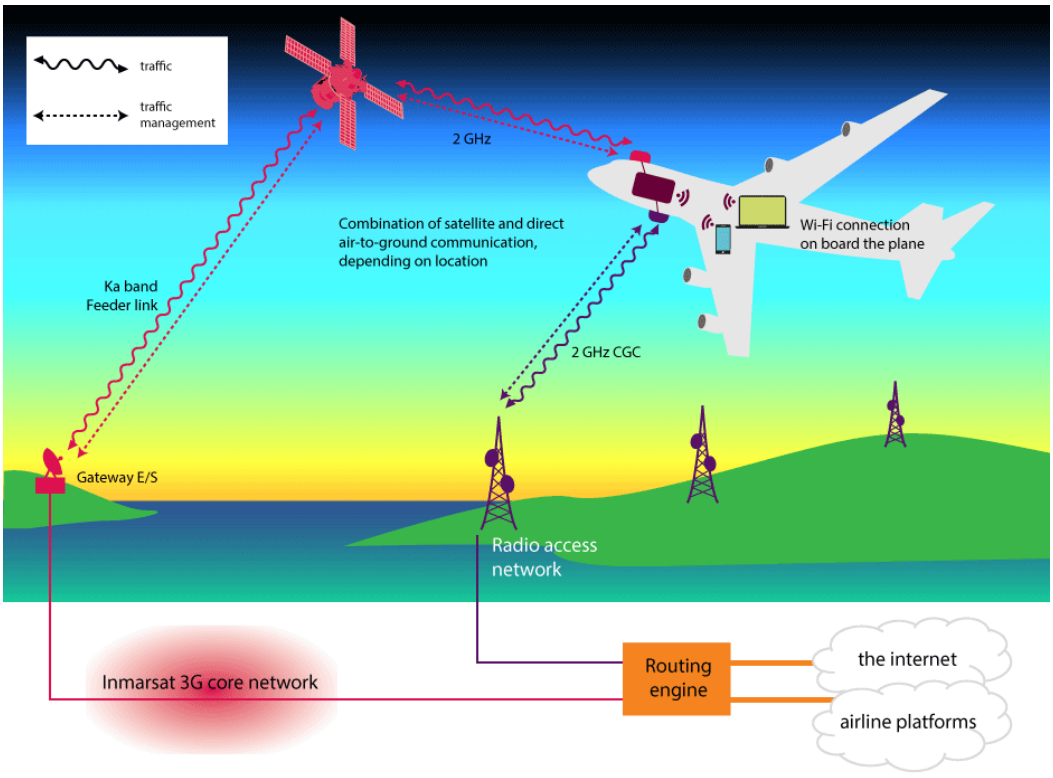
Section 4

Inmarsat's planned aeronautical broadband service

4.1 Inmarsat has told us that, following the successful launch and operation of its 2GHz satellite, it wishes to provide a mobile broadband service to aircraft flying over the EU. They wish to use a combination of satellite and ground based components as part of an integrated system. Inmarsat refers to this service as its "European Aviation Network" or EAN. It plans to provide broadband connectivity to aircraft passengers. It also plans to serve some operational requirements of the aircraft.

4.2 Figure 1, below is a simplified illustration of the system diagram that Inmarsat has shared with us. It illustrates the different elements of Inmarsat's planned service. Note that both the traffic and traffic management links are bi-directional.

Figure 1: Inmarsat's Simplified European Aviation Network (EAN) System diagram



4.3 There are various wireless communication links which form part of the proposed system.

4.4 Passengers on the plane use their own devices (smartphone, tablet, laptop etc.) to access broadband services via a standard Wi-Fi connection to the Comms Manager on the aircraft.

4.5 The Comms Manager on the aircraft then connects with the Routing engine on the ground (that Inmarsat refers to its "Integrated Transport" management centre) via one of two terminals on the aircraft:

i) a satellite terminal on the top of the aircraft communicates via the satellite (using the 2 GHz spectrum) and the satellite's associated gateway earth stations / feeder links (using spectrum in Ka-band); and

ii) a terminal (or terminals) on the underside of the aircraft communicates with base stations on the ground that are under the aircraft's flight path. This direct air to ground (DA2G) or CGC service link uses the same 2 GHz spectrum as the satellite component spectrum (exploiting the attenuation provided by the aircraft's fuselage in the separation of the terminals on the top and underside of the aircraft and their different directions of communication). The DA2G segment provides significant additional broadband capacity when the aircraft is flying over heavily used flight paths.

4.6 Inmarsat informs us that the EAN network has been designed as a hybrid network that will allow seamless roaming for users between both the satellite and DA2G segments.

4.7 Inmarsat plans to use the half of the 1980 – 2010 MHz frequency band (the MSS "uplink" band) awarded to it for aeronautical terminal-to-satellite and for aeronautical terminal-to-DA2G base station. It plans to use the half of the 2170 – 2200 MHz frequency band (MSS "downlink" band) awarded to it for satellite-to-aeronautical terminal and for DA2G base station-to aeronautical terminal.[16] The EAN is planned, therefore, to use the same direction of transmission as the MSS satellite component.

4.8 A mechanism within the EAN (known as the "Integrated Transport centre") is intended to operate in a way that will decide whether the aircraft system should use the satellite or DA2G component according to prevailing congestion, traffic load and link quality to make optimum use of the available radio resources.

4.9 Inmarsat informs us that all network elements responsible for the seamless integration of satellite and ground segments of the EAN are planned to be owned and operated by Inmarsat. Inmarsat's Integrated Transport centre is also being planned to ensure that the satellite and ground segments do not interfere with each other, or with services in adjacent bands.

4.10 Inmarsat states that it plans to ensure that the system operates in accordance with relevant European Telecommunications Standards Institute (ETSI) standards and in accordance with the recommendations of ECC Report 233.[17]

4.11 Inmarsat states that it also plans to own and operate the satellite and gateway earth stations. Inmarsat say that the base stations are intended to be planned, built and operated by Deutsche Telecom on behalf of Inmarsat.

4.12 Inmarsat states that the service is planned to cover Europe's land masses, as well as the surrounding seas and neighbouring regions.

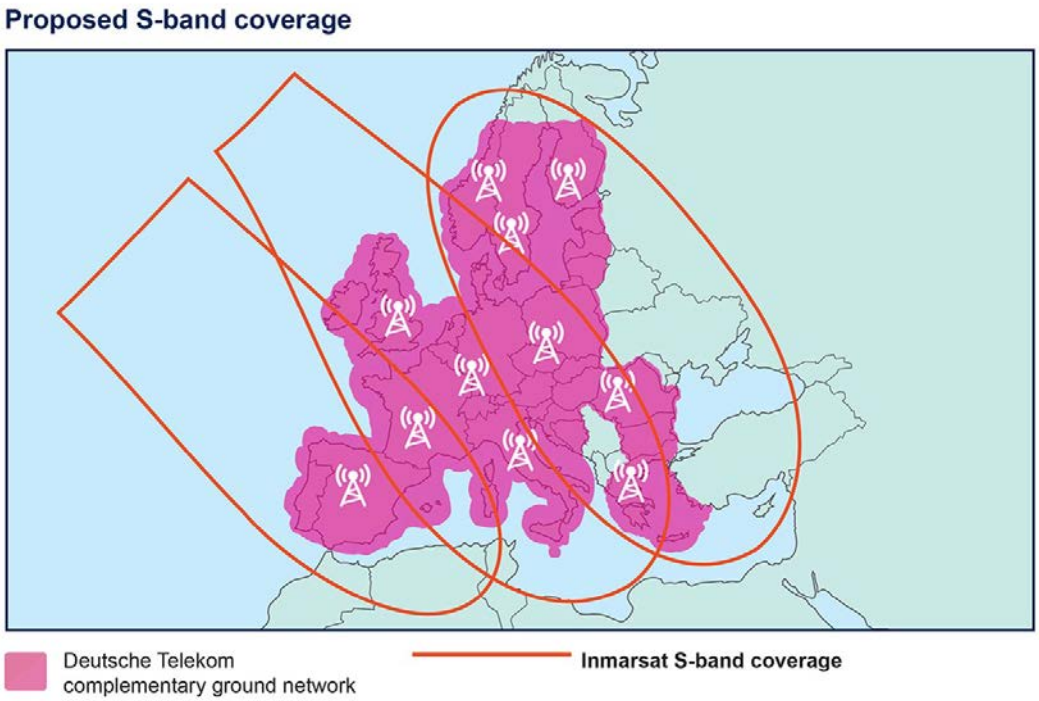
[16] In this document we refer to the entire 2 GHz MSS band as we plan to make the licence available to both companies selected and authorised under the EU harmonised process. Each of the 2 GHz operators would only be permitted to apply for a licence covering the specific frequencies assigned to them in Decision 2009/449/EC.

[17] This is the CEPT Report that described the compatibility studies that CEPT undertook between an aeronautical DA2G service in the 2 GHz band and other adjacent services. We discuss the results of this Report in Section 7 and Annex 5.

4.13 Inmarsat intends to deploy the base stations within the satellite footprint. Roll-out is anticipated to begin mid-2016. Inmarsat is currently planning to test the system in 2017 and intends for the full terrestrial network to be deployed by end 2017/early 2018.

4.14 The intended coverage area of the satellite and base stations is shown in Figure 2 below.

Figure 2: Inmarsat's EAN planned coverage area



Section 5

UK authorisations required for the proposed aeronautical service

5.1 Inmarsat's planned use of the 2 GHz spectrum bands to provide a broadband service to aircraft passengers includes a number of radio elements (as set out in section 4) that will need to be authorised in advance of a commercial roll-out of the service. Some of these authorisations already exist and others will need to be put in place. This section explains the authorisation requirements for each radio component, noting how we expect to put in place authorisations for those radio elements that have not yet been authorised.

5.2 As set out in the previous section, the MSS system provides two main links from the aircraft to public terrestrial networks such as the internet:

- the MSS satellite link, and
- the DA2G link.

5.3 We cover each of these in turn below before touching on the wireless links inside the aircraft itself.

The MSS satellite link

5.4 The MSS satellite link would comprises two distinct radio elements. These are:

i) the MSS satellite; and

ii) the satellite terminal installed on the top of the aircraft which communicates with the MSS satellite.

MSS satellite

5.5 As described in Section 3, Inmarsat was granted an authorisation under the EU legislative framework for MSS. That authorisation was provided by Decision 2009/449/EC. In turn, the EU framework required the UK to grant an authorisation for the frequencies used. As set out in section 3, the UK implemented the EU Decisions via the Regulations and Inmarsat's Authorisation was granted on 31 August 2010.

Terminal on aircraft

5.6 In common with any radio station or apparatus, aircraft radio stations (the radio equipment carried by UK-flagged aircraft) must be authorised by us under the Wireless Telegraphy Act 2006. We therefore issue an Aircraft Radio Licence in respect of each UK-flagged aircraft. We believe that the UK Aircraft Radio Licence also meets our international obligations[18]

[18] The 1944 Chicago Convention on International Civil Aviation is the principal international convention on civil aviation. Under Article 30 of this Convention, aircraft flying over another administration may carry radio apparatus if the apparatus is covered by a licence to install and

5.7 Accordingly, the satellite terminal installed on the top of the aircraft would require authorisation. We anticipate that this would be done under Ofcom's usual approach to licensing, by including it in the Aircraft Radio Licence described above. Additional pieces of radio equipment not normally covered by the Aircraft Radio Licence (such as the satellite terminal) can be authorised for a particular aircraft by formally varying the Aircraft Radio Licence. For these satellite terminals, this would be on demand and free of charge.

5.8 However, we note that the technical conditions (needed to enable us to offer this variation) have not yet been finalised through ETSI. We expect to consult on this later in 2016 once the ETSI work has been finalised.

5.9 We do not authorise the installation or use of radio equipment on visiting (foreign registered) aircraft. However, under the Wireless Telegraphy (Visiting Ships and Aircraft) Regulations 1998 (S.I. 1998/2970), the radio equipment on visiting aircraft must be used such that it does not cause interference to wireless telegraphy. We can take remedial action in respect of interference traced to a visiting aircraft.

Satellite gateway earth station

5.10 The satellite component also requires the use of satellite gateway earth stations. We understand these are planned to be located in other countries and so do not require UK authorisation.

The DA2G link

5.11 The DA2G link that provides a link from the aircraft directly to the CGC base station would involves two distinct radio elements. These are:

i) the terminal (or terminals) installed on underside of the aircraft communicating with the ground base stations; and

ii) the base stations located on the ground at various locations across Europe (with some located in UK).

Terminal on aircraft

5.12 In relation to the terminal on the underside of the aircraft, we would take the same approach to authorisation as for the terminal installed on the top of the aircraft (as described above).

DA2G ground stations

5.13 The ground based stations will need to be authorised via a wireless telegraphy licence under section 8 of the Wireless Telegraphy Act 2006. The form of this licence is the subject of this consultation and the conditions that we propose to apply to this licence are set out in sections 7 and 8.

operate it. Article 18 and Appendix 16 of the Radio Regulations (published by the International Telecommunication Union) also provide that an aircraft must carry a licence that covers the radio equipment on board.

Wireless use on board the aircraft

Wi-Fi router

5.14 The Wi-Fi router on board the aircraft (which forms part of the Comms manager) is exempted from the need for a licence under the Wireless Telegraphy Act. However, in order to allow aircraft to meet the requirements of the Chicago Convention that all radio equipment on an aircraft is covered by a licence (see footnote 19), we expect to add this Wi-Fi application as an available Notice of Variation of an Aircraft Radio Licence (taking the same approach as for the terminals installed on the aircraft described above).

Passenger devices

5.15 Finally the smartphones, tablets and laptops which are in possession of passengers and others on board aircraft when operating in Wi-Fi mode are already exempted from the need for a licence.

Section 6

Consistency with the EU legislative framework for CGC

6.1 Inmarsat is proposing to provide this service using the spectrum access rights that it holds under the pan-European award process. As set out in paragraph 3.3 to 3.7 above, Inmarsat holds an authorisation to use the relevant frequencies between the satellite and ground user terminals in the UK under the Regulations.

6.2 The Regulations specify, in accordance with the EU legislation, that either company must be granted on request a complementary ground component licence.

6.3 In light of Inmarsat's plans, which Ofcom has been informed of, Ofcom has given thought to whether the base stations of the DA2G component could be authorised by Ofcom by means of the CGC wireless telegraphy licence and, if so, whether that would be appropriate.

6.4 Decision 626/2008/EC defines CGC:

> "'complementary ground components' of mobile satellite systems shall mean ground-based stations used at fixed locations, in order to improve the availability of MSS in geographical areas within the footprint of the system's satellite(s), where communications with one or more space stations cannot be ensured with the required quality."

6.5 It should be noted that although the definition of CGC in Decision 626/2008/EC and Decision 2007/98/EC includes the phrase "in order to improve the availability of MSS", the term "MSS" is defined in these Decisions as the combination of the satellite component and the CGC (i.e. it is not limited to the satellite component). Accordingly, any service carried over the CGC will, by definition, improve the availability of MSS as defined in the Decisions.

6.6 From the information given to us by Inmarsat we understand that Inmarsat plans to deploy CGC through the use of terrestrial base stations at fixed locations. These stations would be located within the footprint of their MSS satellite component and would be used to provide additional capacity to the MSS satellite component in areas of high demand, such as high density flight paths. If the MSS system did not include the CGC then the quality of the service aboard aircraft would suffer. This is because the "contention ratio" would be increased beyond the effective capacity of the MSS satellite component.

6.7 We, therefore, consider that Inmarsat's planned use of CGC meets the definition of CGC as set-out in the Decision 626/2008/EC.

Section 7

Proposals for licensing Inmarsat's DG2A base stations

7.1 In 2009, when we made the Spectrum Access 2 GHz Licence available on request (to Inmarsat and Solaris / EchoStar), there were no concrete plans for the type of service that CGC might support. As set out above, Inmarsat is now proposing to use the terrestrial CGC component of the MSS to offer a mobile broadband service to aircraft as part of a combined satellite and terrestrial system. Inmarsat has, therefore, requested Ofcom to review the authorisation regime for the CGC component to facilitate this use for UK-based CGC base stations.

7.2 Our view is that it would be appropriate to base a wireless telegraphy licence to authorise the base stations on the terms and conditions of the Spectrum Access 2 GHz Licence that we have already consulted and concluded on in 2009. However, adapting these terms and conditions, where appropriate, to reflect the requirements of the proposed aeronautical service. In particular, we propose to adapt:

- the format of the licence from a UK-wide Spectrum Access Licence to a site specific Network Licence (in which transmissions are authorised at specific ground stations sites, listed in a schedule) – we refer to the proposed licence as the “”Network 2 GHz Licence”;
- the technical conditions so as to reflect the needs of the DA2G service whilst still protecting adjacent spectrum users; and
- the structure of the fee.

7.3 We believe the other non-technical conditions of the Spectrum Access 2 GHz Licence remain fit for purpose for the proposed Network 2 GHz Licence.

7.4 In particular, in accordance with the requirements of the Regulations the licence will include a fixed term to 2027.

7.5 This licence would, in principle, be also available to EchoStar (although EchoStar has, to date, made no specific request of us in respect of 2 GHz CGC authorisation).

7.6 We consider that this Network 2 GHz Licence should only become available to the 2 GHz MSS operators following the:

- successful launch of their MSS satellite,[19] as we consider this to be appropriate in light of the enforcement action referred to earlier (noting that, in any case, Inmarsat has requested the licence be available subsequent to the launch of the MSS satellite component); and
- conclusion of the consultation process covering the authorisation of the terminals installed on the aircraft. We are not able to consult on these arrangements until the associated work has been completed in ETSI.

[19] And subject to the conclusion of the current enforcement action

7.7 This approach would enable us to have certainty that all elements of the system would not cause harmful interference to other users before authorising any part of the system.

7.8 The Spectrum Access 2 GHz Licence will continue to be available to either 2 GHz MSS operator (to enable them to deploy, for example, a terrestrial mobile service). However, we propose that the same condition is adopted as for the Network 2 GHz Licence, namely that it will only be available to a 2 GHz operator once its MSS satellite is launched successfully. [20]

The licence "common conditions"

7.9 As set out in our 2009 statement the proposed CGC wireless telegraphy licence would contain the "common conditions" which are required for each Member State's authorisation by the EU legislative framework (Decision 626/2008/EC), and also by the UK regulations.

7.10 The four common conditions are:

i) operators shall use the assigned radio spectrum for the provision of complementary ground components of mobile satellite systems;

ii) complementary ground components shall constitute an integral part of the mobile satellite system and shall be controlled by the satellite resource and network management mechanisms; they shall use the same direction of transmission and the same portions of frequency bands as the associated satellite component and shall not increase the spectrum requirement of the associated satellite system;

iii) independent operation of complementary ground components in case of failure of the satellite component of the associated mobile satellite system shall not exceed 18 months;

iv) rights of use and authorisations shall be granted for a period of time ending no later than the expiry of the authorisation of the associated mobile satellite system.

7.11 We consider each of these in turn.

Use of the assigned radio spectrum for CGC

7.12 As explained above, Inmarsat's Authorisation authorises it to use the frequency bands from 1980 to 1995 MHz for earth to space communications and from 2170 to 2185 MHz for space to earth communications. However, we propose the new Network 2 GHz Licence for CGC would be available to both 2 GHz operators but would only permit the use of the frequency bands they have been awarded under Decision 2009/449/EC.

Requirement for CGC to constitute an integral part of the mobile satellite system

7.13 As we discuss in paragraphs 4.6-4.11 above, Inmarsat's have stated that its proposed broadband to aircraft system is designed as a hybrid network that allows roaming by the aircraft between both the satellite and DA2G segments. The

[20] And subject to the conclusion of the current enforcement action

"Integrated Transport centre" decides whether to use the satellite or ground component according to prevailing congestion, traffic load and link quality to make optimum use of the available radio resources.

7.14 All network elements responsible for the seamless integration of satellite and ground segments of the system are intended to be owned and operated by Inmarsat.

7.15 Inmarsat's Integrated Transport centre is also intended by Inmarsat to work in a way which ensures that the satellite and ground segments do not interfere with each other, or with services in adjacent bands.

Independent operation of the MSS satellite

7.16 We have not been requested to licence the CGC in advance of the successful launch of the MSS satellite component and we do not propose to do so. We propose to include a condition (as in the Sample Spectrum Access 2 GHz Licence of 2009) that restricts such independent operation in the light of a subsequent failure of the MSS satellite component to 18 months, as required by the European legislation.

Term of licence

7.17 We propose to include a condition limiting the licence to a fixed term expiring on the same date as the authorisation for the satellite component of the MSS.

CEPT compatibility studies for aeronautical use

7.18 Inmarsat plans to use the LTE Radio Access Network (eNodeB) at DA2G base stations. These ground based DA2G base stations are comparable to mobile cellular base stations operating, or planned to be operated in the adjacent bands

7.19 The CEPT has studied the co-existence issues for Inmarsat's planned aeronautical use and systems operating in the adjacent bands. The conclusions are presented in ECC Report 233. We understand that representatives of the potentially affected parties participated in this work and concurred with its conclusions. The report looks at eleven potential interference scenarios to other adjacent systems. Systems studied are:

- DA2G,
- Cellular networks,
- Video - Program Making and Special Events (PMSE), Video Link Cordless Cameras (VLCC),
- Mobile Communication on Aircraft (MCA) and
- LTE-public mobile use by CGC of other MSS systems.[21]

7.20 The report recommends five mitigation measures to prevent harmful interference. All mitigation measures relate to the Aeronautical DA2G terminal. The ECC Report concludes that no special mitigation measures are required for the DA2G base

[21] See ECC Report 233 for details of the compatibility analysis and required mitigations: http://www.ecodocdb.dk/doks/relation.aspx?docid=2561

station. This can function with the basic system parameters as prescribed in the maximum permissible power level and Block Edge Mask we propose, below, to be included in the Technical conditions of the proposed Licence.

DA2G base stations

7.21 We have carried out technical due diligence on the ECC Report 233 and are content that ECC Report 233 makes a thorough assessment of the interference scenarios and the potentially affected adjacent systems.

7.22 We are also satisfied that any proposed Complement Ground Component system operating in the 1980 – 2010 MHz and 2170 – 2200 MHz band and licensed in accordance with the technical conditions set-out in this section is in accordance with the assumptions made in ECC Report 233 and, therefore, will not cause harmful interference to adjacent users. We provide further detail on the technical due diligence we have undertaken to come to this conclusion in Annex 5.

Aeronautical terminals

7.23 In Annex 5 we also provide details on our understanding of the mitigations that would be required for the aeronautical terminals on the aircraft, so that we would be satisfied that, if these terminals conform to the conclusions of the ECC Report 233, they will also not cause harmful interference. We are not currently consulting on any aspect of the authorisation of the Aeronautical terminals as we do not have sufficient certainty on the technical conditions that these terminals will require.

7.24 As previously indicated we propose to carry-out technical due diligence on the proposed technical conditions for the associated aeronautical terminals once the ETSI standards are finalised later in 2016. We expect to base this due diligence on the conclusions of ECC Report 233.

Technical Licence conditions

7.25 Inmarsat has proposed a set of technical licence conditions and we have reviewed these against the findings of ECC Report 233. In summary, we consider that the conditions put forward by Inmarsat should provide adequate protection to adjacent users for the reasons set out in this section and in Annex 5.

7.26 These technical licence conditions, that we propose to include in the licence, are as follows:

- a maximum permissible power of 62dBm / 5 MHz EIRP and 55dBm / MHz EIRP;
- The Block edge mask shown in Table 1 below.

Table 1: Proposed Block edge mask

Offset from relevant block edge	Maximum mean EIRP for out-of-block emissions
-1.5 to -10 MHz (lower block edge)	+3.5 dBm/MHz

-1 to –1.5 MHz (lower block edge)	-9.5 dBm/30 kHz
–1 to –0.2 MHz (lower block edge)	Linear from -9.5 dBm/30 kHz to +2.5 dBm/30 kHz
–0.2 to 0.0 MHz (lower block edge)	+2.5 dBm/30 kHz
0.0 to +0.2 MHz (upper block edge)	+2.5 dBm/30 kHz
+0.2 to +1.0 MHz (upper block edge)	Linear from +2.5 dBm/30 kHz to -9.5 dBm/30 kHz
+1.0 to +1.5 MHz (upper block edge)	-9.5 dBm/30 kHz
+1.5 to +10 MHz (upper block edge)	+3.5 dBm/MHz

7.27 The Technical conditions will also reference the relevant ETSI standard in the Interface Requirements (IR) of the licence.[22]

7.28 We provide a sample of the proposed Network 2 GHz Licence in Annex 6. This will take the form of a single Licence with a Schedule attached that provides the location details of the individual locations which the licensee is authorised to install and transmit CGC base stations in UK.

Question 1: Do you have comments on Inmarsat's planned use of the spectrum, our planned approach to authorising the overall MSS and CGC system, the availability of the Network and Spectrum Access 2 GHz Licences, or any other aspect of the scope and purpose of this document?

Question 2: Do you have any comments on the technical conditions we propose to include in the Network 2 GHz Licence?

[22]EN 302 574-1

Section 8

Spectrum fees

Introduction

8.1 In this section we set-out our proposals for wireless telegraphy fees for the Network 2 GHz Licence. In doing so we are mindful that there should be a measure of consistency between these fees and those which we concluded on for the Spectrum Access 2 GHz Licence in 2009.

8.2 As set out in section 7, we propose to move from a UK-wide Spectrum Access Licence to a site specific Network Licence. We are proposing this because we believe there is merit in providing incentives for the aeronautical CGC operator to locate its base stations outside areas of high population given that:

- Inmarsat is looking to install a relatively small number of sites (10 – 25 in UK);
- there is significant flexibility in where these small number of sites can be located to provide the service and therefore there are opportunities for Inmarsat to make location decisions informed by price; and
- our current experience indicates that the demand for many/most high value uses of spectrum is largely driven by population density.

8.3 In this section, therefore, we provide our proposals and reasoning for:

- the level of the fee;
- the structure of the fee;
- the implementation of the location factor of the fee;

8.4 Finally we provide an analysis of the fees options we considered in coming to these proposals.

Level of fee

8.5 We explained in section 2 that the Spectrum Access 2 GHz Licence will remain available so that Inmarsat and EchoStar will have a choice as to which form of licence to apply for. We consider that there should be a measure of consistency between these licences on the level of fee charged (at the UK-wide level).

8.6 Our 2009 statement set out a fee for the Spectrum Access 2 GHz Licence of £554,000 per 2 x 1MHz per annum UK-wide. We note that this rate for a UK-wide licence recognised the possibility that this spectrum could be used for public terrestrial mobile. However, we also noted a number of uncertainties that argued that the opportunity cost of the 2 GHz spectrum might be lower than that of public terrestrial mobile. This included the uncertainty over how the ecosystem for equipment might develop and the uncertainty of the spectrum becoming available for public terrestrial mobile throughout Europe. As we discussed in our 2009 statement, the implementation of the EU Decisions in respect of the permitted uses of spectrum

for CGCs could vary by administration and, therefore, public mobile use of the CGC spectrum might not be permitted by all administrations in Europe.

8.7 We recognised that there might be case to look at the UK-wide level of fee as and when more information became available. However, we believe that the kinds of uncertainties described in our 2009 statement still apply. In particular, they haven't changed in a way that would give us firm grounds to review the fee rate for the Spectrum Access 2 GHz Licence set out in 2009.

8.8 In light of the above, we propose to also take the £554,000 per 2 x 1MHz per annum rate for UK-wide spectrum access as the starting point for the fees in the Network 2 GHz Licence.

Structure of fee

8.9 However, as we explained above, we propose to adapt the UK-wide fee into a site-based fee. This will take the form of a fee for each individual base station installed, where this site-based fee includes a location factor based on population density. We propose to do this because, as discussed above, we wish to incentivise the 2 GHz operators to locate their base stations outside of highly populated areas

8.10 The proposed Network 2 GHz Licence takes the form of a single Licence with a Schedule attached that provides the location details of the individual locations which the licensee is authorised to install and transmit CGC base stations in UK. We expect that, when the operator applies for the licence initially, it will provide details of all the locations that it plans to install CGC base stations.

8.11 The main difference between the Spectrum Access 2 GHz Licence and the Network 2 GHz Licence will, therefore, be that the former is UK-wide and the latter is site specific.

Implementation of the location factor in the fees

8.12 We propose that the existing UK-wide fee of £554,000 per 2 x 1 MHz is pro-rated against a set of individual geographical areas (defined by grid squares) within the UK. We propose to do this in a way that reflects the fact that spectrum access is, in general, more valuable in areas with greater population density given that this is what typically drives high value uses.

8.13 We propose a pragmatic approach to do this using the existing methodology developed and implemented for our business radio fees.[23] This approach employs a set of grid squares 50 km x 50km that are each characterised, for business radio use, as high, medium or low demand based on the population density in each square.

8.14 The business radio methodology resulted in 247 grid squares:

- one of high demand, which provides coverage of London, Category A;
- 47 of medium demand, Category B; and
- 199 of low demand, Category C.

[23] http://stakeholders.ofcom.org.uk/consultations/busrad/statement/

8.15 The ratio of fee level between these three tiers of fee is based on relative population density in the three different categories of grid square. Applying these ratios to the £554,000 per 2x 1 MHz UK-wide fee for 2 GHz MSS CGC results in the following fees per base stations per location category provides the following fees:

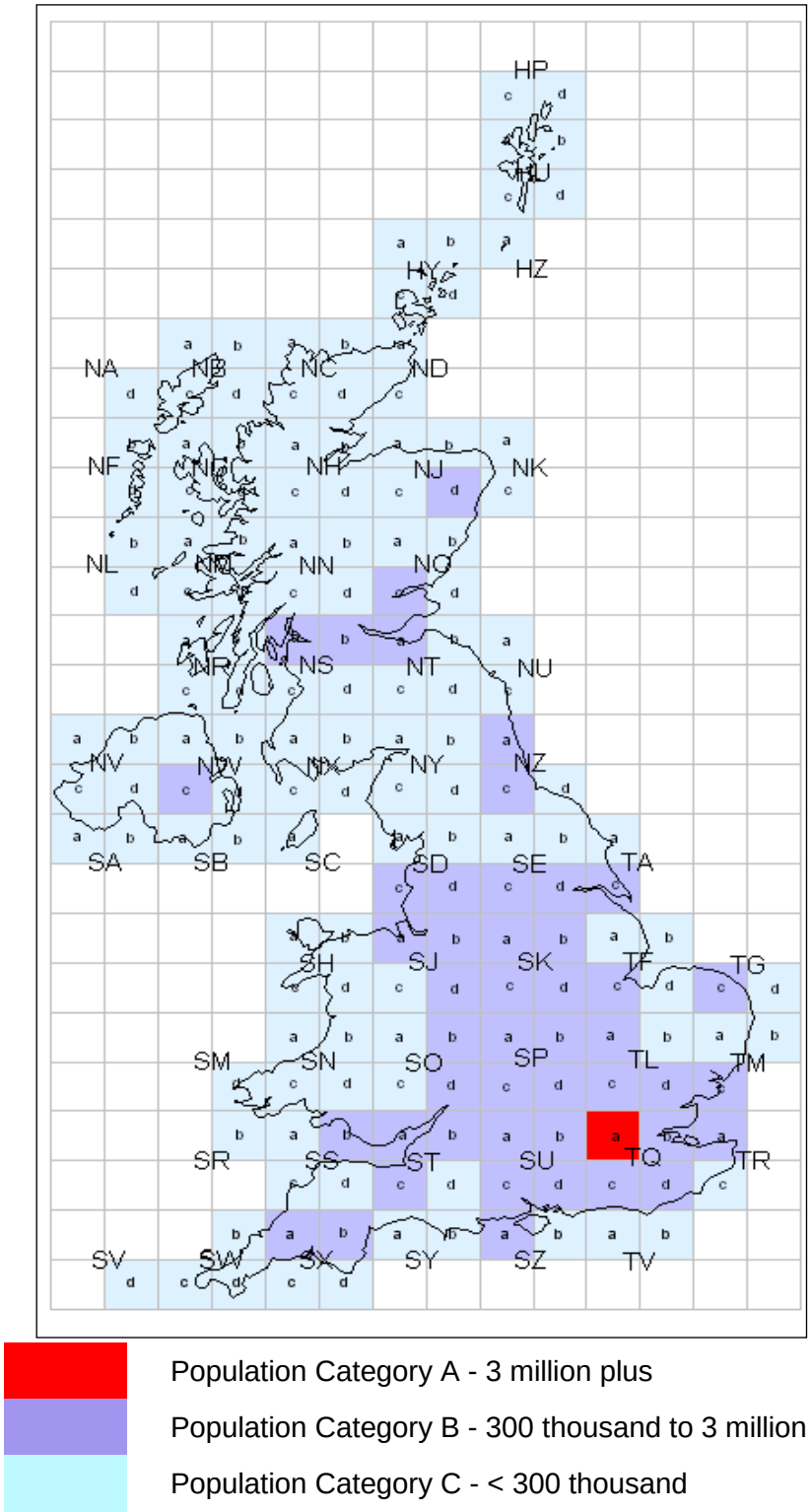
Location category	Fee per base station per 2x1 MHz	Fee per base station fee per 2 x15 MHz[24]
A - High demand	£64,000	£960,000
B - Medium demand	£8025	£120,375
C - Low demand	£825	£12,375

8.16 As such, if the CGC operator installed a base station in each of the grid squares in the UK, the applicable fee would be the UK-wide fee as for the Spectrum Access 2 GHz Licence from 2009.

8.17 We provide the map in Figure 3, overleaf, identifying the specific geographic locations of these different location categories.

[24] Each operator has a maximum of 2 x 15 MHz that can be assigned to the CGC and so this represents the maximum fee per site in each type of location

Figure 3: Map of population density categories proposed to be used for the Network 2 GHz Licence fees



8.18 We consider that the use of the business radio model (rather than developing a new methodology) to implement the location factor is a pragmatic one that is proportionate to the need. We note we have consulted on this methodology before and therefore have comfort that it adequately reflects the population density and, therefore the relative demand from alternative services in these locations.

8.19 If the licensee installs more than one base station in a single square then it will attract a fee for each base station. This approach will discourage the operator from using this Network 2GHz Licence to deploy multiple base stations in urban areas, for example as part of a terrestrial mobile network. Indeed, if the operator were to install multiple base stations in multiple squares, then the applicable fee could become greater than the UK-wide fee under the alternate Spectrum Access 2 GHz Licence for CGC use in this spectrum. However, the operator can choose which of the two CGC licences to apply for, based on its plans for using the spectrum. In the case where the operator wanted to install a large number of sites it would be more appropriate for them to apply for the UK-wide Spectrum Access 2 GHz Licence set out in our 2009 statement.

8.20 We consider this approach to be a pragmatic means of implementing a location factor for a Network 2 GHz Licence. We believe that it will give incentives to the CGC operators to locate CGC base stations, where possible, outside of high population locations. It may, therefore, improve future sharing opportunities. We therefore consider this approach to be both reasonable and proportionate in this situation.

Analysis of fees options

8.21 This is a unique situation in which the spectrum has not just been mandated to a service through a mandatory EU harmonised allocation, it is also mandated for specific spectrum assignment to specific organisations. Therefore, assuming these companies meet their obligations under the EU process, they alone are able to make use of the spectrum until 2027, unless it is traded (and even following a trade the operator(s) would need to retain the obligations and responsibilities and therefore a significant interest in the use of the spectrum through a concurrent trade).

8.22 We therefore wish to derive spectrum fees that, during the term of the licence, provide the appropriate incentives for the licensees to use the spectrum efficiently. We also wish to have fees that provide longer term incentives to use the spectrum efficiently.

8.23 In particular, we have a specific strategic objective to facilitate greater sharing of spectrum and anticipate that these will, in many cases, arise from geographic sharing. A major hurdle to geographic sharing can be the locations of existing transmission sites, even when these may be few in number. Transmission sites are costly to relocate and have much longer investment lifecycles than radio equipment. Therefore, where appropriate, we wish to incentivise the location of transmission sites outside of areas of future high value to other services. By doing so we hope to encourage innovation in sharing technologies and techniques by maximising the future gains that such innovation can bring.

8.24 We therefore considered two approaches for the Network CGC fees:

- Option 1: to charge a UK-wide fee for the use of the spectrum at £554,000 per 2x1 MHz, as in the Spectrum Access 2 GHz Licence of 2009; or

- Option 2: to adapt the UK-wide fee to provide a site based fee for each individual base station installed, where this site based fee includes a location factor based on population density, as we propose.

8.25 In deriving appropriate fees for the Inmarsat service we wish to use a pragmatic approach that is proportionate to the incentives the fee is likely to provide. I.e. the

likely impact on the investment behaviour of the licensee over the term of the licence. In particular, we are keen to set a fee that provides an appropriate balance between:

- setting a fee that reflects the opportunity cost of its use,
- creating the appropriate medium term incentives, and
- creating the appropriate long term incentive to maximise the future opportunities for innovation and sharing where this does not impose unnecessary constraints on the CGC use.

8.26 The first option, to charge a UK-wide fee offers a number of advantages:

- It provides the licensee with total flexibility to install any number of base station in any location with no impact on the fee it pays;
- It provides parity between the fees for this licence and the Spectrum Access 2 GHz Licence concluded on in 2009;
- It reflects the opportunity cost of the use of the band for the highest value alternative use (terrestrial mobile) subject to the same kinds of uncertainties that we discussed in our 2009 statement.

8.27 However, the UK-wide fee approach also has some disadvantages:

- It provides no incentive to limit the number of base stations;
- It provides no incentive to locate the base stations outside highly populated areas – even though there may be no dis-benefit to Inmarsat of doing so;
- It is likely to result in long term investments in sites that would deter investment by others in innovation to enable sharing in the high value geographies; and
- Could therefore make future sharing opportunities both more unlikely and more costly.

8.28 We recognise that the opportunities for sharing this spectrum currently are relatively low, not least because of the need to protect the satellite component use. However, we do not have the power to charge fees for MSS satellite component licence.

8.29 The second option, to adapt the fee and charge on a location basis for each individual CGC base station provides a number of advantages:

- It provides incentives to minimise the number of base stations and to avoid locating these in highly populated areas, when not required to deliver the service;
- The effort and resource to implement the fee remains proportionate to the benefits it is anticipated to deliver to consumers and citizens; and
- It is likely to maximises the potential “future white space” available for sharing with other services.

8.30 The second option has the disadvantages that it is likely to:

- underestimate the relative value of the denial area of the spectrum created by the use of a single CGC base station in a grid square; and

- overestimate the relative value of the denial area of the spectrum created where multiple base stations are located in a single grid square.

8.31 However, given the use planned by Inmarsat we note that:

- If we were to reflect the full opportunity cost of the spectrum we would likely result in a fee at, or close to the UK-wide fee, which would provide no incentive to locate base stations outside highly populated areas and therefore fail to achieve one of our key policy objectives; and

- Inmarsat plans to locate only a small number (10-25) of base stations in the UK and, therefore, it is unlikely that they will wish to install more than one or exceptionally two base stations in a single grid square limits. This, therefore, limits the risk of over-estimating the opportunity cost through this approach;

- In the case that Inmarsat wishes to deploy large numbers of base stations, for example to support terrestrial mobile use, the existing Spectrum Access 2 GHz Licence, from 2009, would still be available to them on request.

8.32 In conclusion we consider that the second option provides us with the ability to create incentives that could provide greater opportunities for sharing spectrum in the longer term and that this outweighs the disadvantages of this approach given the planned use by Inmarsat.

Question 3: Do you have any comments on our proposals for the fee level, fee structure and implementation of the location factor for the fee for the Network 2 GHz Licence?

Section 9

Next steps

9.1 We expect to publish a Statement on the authorisation of aeronautical use of the 2 GHz MSS spectrum and, in particular, on the proposed DA2G licence and associated fees, following consideration of stakeholder responses to this consultation. We would also need to publish a Notice on the associated fees regulations, and then make the necessary fees regulations, before issuing a Network 2 GHz Licence.

9.2 As noted in section 2, this document is consulting only on the licensing arrangements for the ground station element of the CGC component of Inmarsat's service. We will also need to have arrangements in place to authorise the terminals and Wi-Fi router on the aircraft before Inmarsat can commence service. We expect to consult on the arrangements to authorise these later in 2016, once the necessary work has been completed in ETSI.

9.3 As noted in section 2, we also propose that the Network 2 GHz Licence only becomes available to the operators following the:

- successful launch of their MSS satellite; [25] and
- conclusion of our subsequent consultation(s) on the authorisations for the remaining elements of the system on board the aircraft.

[25] And subject to the conclusion of the current enforcement action

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 18 April 2016**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at https://stakeholders.ofcom.org.uk/consultations/2GHz-mobile-satellite-systems/howtorespond/form, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email MSS_CGC@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

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

Alison Esslemont
Floor 3
General Policy Team, Spectrum Group
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.5 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.6 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Alison Esslemont on 020 7981 3147.

Confidentiality

A1.7 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether

all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.8 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.9 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/terms-of-use/

Next steps

A1.10 Following the end of the consultation period, Ofcom intends to publish a statement later in 2017.

A1.11 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/email-updates/

Ofcom's consultation processes

A1.12 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.13 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.14 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Graham Howell, Secretary to the Corporation, who is Ofcom's consultation champion:

Graham Howell
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email Graham.Howell@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. 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

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at http://stakeholders.ofcom.org.uk/consultations/consultation-response-coversheet/.

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

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

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

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

DECLARATION

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

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name

Signed (if hard copy)

Annex 4

Consultation questions

A4.1 This consultation asks for stakeholders' views on the following:

Question 1: Do you have comments on Inmarsat's planned use of the spectrum, our planned approach to authorising the overall MSS and CGC system, the availability of the Network and Spectrum Access 2 GHz Licences, or any other aspect of the scope and purpose of this document?

Question 2: Do you have any comments on the technical conditions we propose to include in the Network 2 GHz Licence?

Question 3: Do you have any comments on our proposals for the fee level, fee structure and implementation of the location factor for the fee for the Network 2 GHz Licence?

Annex 5

Technical due diligence

Introduction

A5.1 The following annex explains the technical due diligence we have undertaken to satisfy ourselves that the technical conditions we propose to include in the Network 2 GHz Licence will not cause harmful interference to adjacent users.

A5.2 This annex also provides some technical information on the aeronautical terminals. This information is provided for completeness and so that we are satisfied that, if these terminals conform to the conclusions of the compatibility studies undertaken, they will also not cause harmful interference.

Current status of compatibility studies for aeronautical CGC use

A5.3 CEPT has studied the co-existence issues for Inmarsat's planned aeronautical use and systems operating in the adjacent bands. The conclusions are presented in ECC Report 233. We understand that representatives of the potentially affected parties participated in this work and concurred with its conclusions. The report looks at eleven potential interference scenarios to other adjacent systems. Systems studied are:

- Direct to Air to Ground (DA2G),
- Cellular networks,
- Video - Program Making and Special Events (PMSE), Video Link Cordless Cameras (VLCC),
- Mobile Communication on Aircraft (MCA) and
- LTE-public mobile use by CGC of other MSS systems.[26]

A5.4 We are content that ECC Report 233 makes a thorough assessment of the interference scenarios and the potentially affected adjacent systems. To come to this conclusion we have:

- assessed the input assumptions in ECC Report 233. All assumptions are reasonable and representative of both the proposed CGC system and the potentially affected systems;
- reviewed the 11 interfering scenarios studied in ECC Report 233. These adequately study the co-existence issues between the proposed CGC system and potentially affected systems; and

[26] See ECC Report 233 for details of the compatibility analysis and required mitigations: http://www.ecodocdb.dk/doks/relation.aspx?docid=2561

- reviewed the mitigations to prevent harmful interference. These mitigations align with the 11 interference scenarios and will be adequate to reduce the risk of harmful interference.

A5.5 The report recommends five mitigation measures to prevent harmful interference. All mitigations measures relate to the first six interference scenarios involving the Aeronautical CGC terminal. Three mitigation measures apply directly to the Aeronautical CGC terminal while two measures apply to the adjacent systems.

i) The first Recommendation is for the aircraft terminal: Improved transmitter filtering and EIRP reduction depending on the altitude and fuselage attenuation that the aircraft provides. These mitigations are required so that the power flux density limits derived in the conclusions of ECC Report 233 can be obeyed and harmful interference does not occur;

ii) The second recommendation is for the PMSE / VLCC equipment: PMSE/ VLCC receivers may need to be de-pointed or shielded from Aeronautical CGC terminals to avoid interference. In ECC Report 233, interference scenarios 5 and 6 identified that the interference to noise threshold of a PMSE / VLCC receiver could be exceeded when it is pointed towards the interferer or at an aircraft fitted with a DA2G terminal. On balance we consider that this recommendation is a realistic mitigation and that harmful interference is unlikely. We consider that:

- There are only some situations and applications where PMSE / VLCC will need to be pointed at aircraft;
- A conservative method was used in the interference assessment and it would be unlikely systems would be operated close to receive thresholds;
- The minimum PMSE / VLCC receiver performance criteria of 30 dB ACS was assumed. This is the worst case; typically equipment should be better, depending on brand make and model
- PMSE / VLCC operators can increase the power when operating to aircraft to overcome any interference. Some units may have a selection of power amplifiers that can be fitted;
- PMSE / VLCC operators can decrease the modulation index for more robustness / margin;
- Any interference will be short term when the aircraft flies past and error correction codes should reduce the effect; and
- There is the possibly an option for additional filtering to be added and some units already have different filtering options available.

The UK licenses the adjacent 2010 – 2025 MHz band for PMSE / VLCC use and there are currently around 70 licences. In addition the European Commission is now considering a Harmonisation Decision for PMSE in the band.

iii) The third recommendation is for the ground component of DA2G systems in the adjacent 2010 – 2025 MHz band; this proposes co-siting of different ground stations, where both CGC and DA2G are installed at the same or nearby locations. This is so that the Aeronautical CGC terminal only transmits at high power when it is a large distance from the CGC and DA2G ground stations keeping interference below the criterion. Because DA2G is not now expected to be implemented in the adjacent band to CGC, this recommendation has been superseded. This is because the European Commission decided not to pursue a decision on harmonisation for DA2G, but instead opted to consider harmonisation of this band for PMSE use.

A5.6 The ECC Report concludes that no special mitigation measures are required for the CGC base station. This can function with the basic system parameters as prescribed in ETSI TS 136 104 V11.6.0 which will be reflected in EN 302 574-1 and the Block Edge Mask proposed to be included in the Technical conditions of the Licence and provided in the Network 2 GHz Licence provided in Annex 6.

CGC Ground Station

A5.7 The CGC base station uses the LTE Radio Access Network (eNodeB). CGC base stations are intended to be installed throughout Europe. Ground based CGC components are planned to be deployed within the confines of the satellite footprint. Inmarsat plans to install a number of base stations in the UK. Network planning still needs to be completed and the exact number of base stations needs to be determined.

A5.8 Each base station is planned to consist of three or more Remote Radio Heads (Sectors). Each sector is planned to have an EIRP 62 dBm / 5 MHz or 55 dBm / MHz and have an up tilt between 5 and 15 degrees above the horizon. The antenna height is planned to be typically 50m AGL but may vary between 25 – 50m. The typical coverage (cell radius) achieved is planned to be 90 km with a costal coverage of 150 km maximum.

A5.9 Inmarsat is currently working in ETSI to update the Harmonised standards EN 302 574-1. This will apply to the CGC base station and is intended to be consistent with the recommendations of the ECC Report 233. EN 302 574-1 is now at its final draft stage and is expected that this will start its approval process in January 2016. Following successful approval it is forecast for publication in October 2016 and citing in the Official Journal of the EU in early 2017.

A5.10 ECC Report 233 assumed in its interference analysis that the adjacent channel leakage ratio was in accordance with ETSI EN 301 908-14 V6.2.1 (2013-10), Clause 4.2.3, Tables 4.2.3.2-1 and 4.2.3.2-2. These values are consistent with other 2100 MHz IMT licences in the UK and the Commission Implementing Decision 2012/688/EU. The values in the new draft Harmonised standard EN 302 574-1 are consistent with the above and will be reflected in the Block Edge Mask in the licences.

A5.11 The ground based CGC base station is comparable to mobile cellular base stations operating in the adjacent bands. Both systems are operating with a comparable EIRP and have similar block edge emission masks. A comparison of the systems can be found in ECC Report 233 Table 17. Any additional interference to user equipment (handsets) from ground based CGC is unlikely be greater than two mobile cellular networks operating adjacent to each other.

A5.12 Studies in the ECC Report 233 assumed an antenna up tilt of 10 degrees above the horizon. We do not believe that this is a key mitigating factor. Our view is that if the antenna was pointed closer to the horizon it might lead to a small increase in interference on the ground in the adjacent band at large distances from the base station. But the highest interference level is very close to the base station, about 100° from the peak direction, and there would be no increase at that point. We therefore do not think it necessary to include antenna up tilt levels as a condition of the Licence.

A5.13 Studies in the ECC Report 233 assumed an antenna height of 30 metres. We do not believe that this is a key mitigating factor. The analysis compared the

interference from a CGC base station with that of a conventional mobile cellular base station of the same antenna height. It is possible that if a lower antenna height was used (say 10m AGL) a higher level of emission in adjacent band is possible. This would not be higher than a mobile cellular base station of the same height and therefore does not increase the risk of harmful interference. It is noted that using a low antenna height may be undesirable as it could be in the clutter and obstructed by buildings, trees etc. We therefore do not think it necessary to include antenna height as a condition of the Licence.

Aeronautical CGC Terminal

A5.14 The aircraft is planned to be fitted with a DG2A terminal, mounted on the bottom of the fuselage of the aircraft to communicate with the ground component (uplink and downlink). CGC terminals transmit in the 1980 – 2010 MHz band and receive in the 2170 – 2200 MHz band, using LTE technology. CGC is part of a hybrid MSS network.

A5.15 The ground facing DG2A terminals are still under development but are expected to support bandwidths of 5, 10 and 15 MHz. Inmarsat plans to ensure that terminals are developed and operated in accordance recommendations conclusions and mitigation measures in ECC Report 233. Ofcom will ensure that appropriate restrictions such as EIRP limits will be placed on the authorisations for the aeronautical terminal when this authorisation is considered by us.

A5.16 The aircraft is planned to also be fitted with an aeronautical terminal mounted on the top of the aircraft to communicate with the satellite (uplink and downlink). Like the DG2A terminal, the satellite facing terminal is planned to transmit in the 1980 – 2010 MHz band and receive in the 2170 – 2200 MHz band. It is expected to be a different technology to the CGC terminal, more suited to a satellite communication channel.

A5.17 EN 302 547-2 is the applicable ETSI Harmonised standard being developed for the ground facing aeronautical CGC terminal. EN 301 473 is applicable for the satellite facing aeronautical terminal. These are currently being updated in ETSI and are now at a final draft. It is expected that ETSI will start its approval process in January 2016. They are forecast for publication in October 2016 and expected to be cited in the Official Journal of the EU in early 2017. Inmarsat plans to ensure that EN 302 574-2 and EN 301 473 will be consistent with ECC Report 233 and incorporate the appropriate mitigations measures. Ofcom will ensure that the authorisation of the aircraft terminals is consistent with the conclusions of ECC Report 233 when we consult on their authorisation.

A5.18 Inmarsat informs us that the Aeronautical CGC terminal, as a result of the improved transmitter filtering, will be able to be operated above 1000 metres altitude without any reduction in EIRP. Below 1000 metres altitude EIRP reduction is required and initially terminals will automatically determine the altitude and be deactivated below this altitude. In future years it expects to develop automatic mitigation that will permit operation below 1000m altitude. Restrictions are expected to be reflected in the authorisation conditions of the aeronautical terminal when we consider this.

A5.19 Inmarsat plans that the ground facing Aeronautical CGC terminal will have a maximum transmit power of 37 dBm with an antenna gain of 3 dBi. The maximum EIRP is planned to be 40 dBm. ECC Report 233 assumed an adjacent channel leakage ratio of 37 dB. The report identified that improved transmitter filtering was required for some interference scenarios. The new draft EN 302 574-2 reflect this

improvement where the adjacent channel leakage ratio has been improved 7 dB from 37 dB[27] to now 44 dB.

A5.20 The satellite facing Aeronautical CGC terminal is planned to have a maximum transmit power of 30 dBm and an antenna gain of 15 dBi. The maximum EIRP will be 45 dBm. Although this is 5 dB higher than the assumptions used in ECC Report 233 we do not believe that this will have any additional impact on the risk of harmful interference. The new draft EN 301 473 sets absolute levels for the unwanted emission mask, meaning that it is independent of the transmitter power. The levels set reflect the improved transmitter filtering and the conclusions of ECC Report 233.

A5.21 We are satisfied that the proposed Complement Ground Component system operating in the 1980 – 2010 MHz and 2170 – 2200 MHz and licensed in accordance with the technical schedule of the Network 2 GHz Licence in Annex 6 is in accordance with the assumptions made in ECC Report 233 and, therefore, will not cause harmful interference to adjacent users.

A5.22 For the Aeronautical CGC terminal the improved transmitter filtering (improved unwanted emissions) mitigating measure will be reflected in the new draft harmonised standards EN 302 574-2 and EN 301 473.

A5.23 In any event, as previously indicated the Licence we are currently consulting on will not become available to the 2 GHz MSS Operators until the successful conclusion of our subsequent consultation(s) on the authorisations for the terminals installed on the aircraft.

[27] This was the assumed ACLR in in Table 6 of ECC Report 233

Annex 6

Example Network 2 GHz Licence

A6.1 This Annex provides an example of the Network 2 GHz Licence we propose to make available for the installation and operation of the 2 GHz MSS CGC networks in UK. This licence refers to the entire frequency bands made available to 2 GHz MSS CGC. Each company, however, would only be able to apply for a licence that covers the frequencies it is authorised to use (i.e. Inmarsat could apply for a licence in respect of the frequencies 2170 to 2185 MHz and EchoStar could apply for a licence in respect of in respect of the frequencies 2185 to 2200 MHz).

Wireless Telegraphy Act 2006
Office of Communications (Ofcom)

NETWORK LICENCE 2170 to 2185 MHz[28]

Licence no. **xxxxx**

Date of issue: **xx xxxxx 2016**

1. The Office of Communications (Ofcom) grants this licence to

Company Name
(Company Reg No: xxxxxx)
("the Licensee")
Address
xxxxxx
xxxxxxxxxxxxxx
xxxxxxxxxxxxxx
xxxxxxxx
xxxxxxxxx

to establish, install and use wireless telegraphy stations and/or wireless telegraphy apparatus as described in the schedule(s) ("the Radio Equipment") subject to the terms set out below.

Licence Term

2. This Licence shall continue in force until 13 May 2027 unless earlier revoked by Ofcom or surrendered by the Licensee.

Licence Variation and Revocation

3. Pursuant to Schedule 1, paragraph 8 of the Wireless Telegraphy Act 2006 ("the Act") Ofcom may not revoke or vary this Licence under Schedule 1, paragraph 6 of the Act except:

(a) at the request, or with the consent, of the Licensee;

(b) if there has been a breach of any of the terms of this Licence;

(c) in accordance with schedule 1 paragraph 8(5) of the Act;

(d) if it appears to Ofcom to be necessary or expedient to revoke the Licence for the purpose of complying with a direction by the Secretary of State given to

[28] Note this sample Licence includes the frequencies awarded to Inmarsat. If EchoStar were to apply for a licence this would include the frequencies awarded to it, namely 2185 to 2200 MHz

Ofcom under section 5 of the Act or section 5 of the Communications Act 2003;

(e) if, in connection with the transfer or proposed transfer of rights and obligations arising by virtue of the Licence, there has been a breach of any provision of regulations made by Ofcom under the powers conferred by section 30(1) and 30(3) of the Act[29];

(f) if UK [Licence number: xxx] is no longer in force

4. Ofcom may only revoke or vary this Licence by notification in writing to the Licensee and in accordance with Schedule 1 paragraphs 6, 6A and 7 of the Act.

Failure of Mobile Satellite Component

5. In the event of failure of the Mobile Satellite Component, independent operation of the Radio Equipment shall not exceed 18 months before the Mobile Satellite Component is restored.

6. This Licence may not be transferred. The transfer of rights and obligations arising by virtue of this Licence may however be authorised in accordance with regulations made by Ofcom under powers conferred by section 30(1) and 30 (3) of the Act[30].

Changes to Licensee details

7. The Licensee shall give prior notice to Ofcom in writing of any changes to the Licensee's name and/or address as recorded in paragraph 1 of this Licence.

Fees

8. The Licensee shall pay to Ofcom the relevant sums as provided in section 12 of the Act and the regulations made thereunder:
a) on or before the date of issue of the Licence;
b) on or before the payment date shown on the Licence for subsequent payments; or such other date or dates as shall be notified in writing to the Licensee, in accordance with those regulations and any relevant terms, provisions and limitations of the Licence.

9. The Licensee shall also pay interest to Ofcom on any amount which is due under the terms of this Licence or provided for in any regulations made by Ofcom under sections 12 and 13(2) of the Act, from the date such amount falls due until the date of payment, calculated with reference to the Bank of England base rate from time to time. In accordance with section 15 of the Act any such amount and any such interest is recoverable by Ofcom.

[29] These are regulations on spectrum trading.
[30] http://www.ofcom.org.uk/radiocomms/ifi/trading/

10. If the Licence is surrendered or revoked, no refund, whether in whole or in part of any amount which is due under the terms of this Licence or provided for in any regulations made by Ofcom under sections 12 and 13(2) of the Act will be made, except at the absolute discretion of Ofcom.

Radio Equipment Use

11. The Licensee shall ensure that the Radio Equipment is established, installed and used only in accordance with the provisions specified in Schedule(s) of this Licence. Any proposal to amend any detail specified in Schedule(s) of this Licence must be agreed with Ofcom in advance and implemented only after this Licence has been varied or reissued accordingly.

12. The Licensee shall ensure that the Radio Equipment is operated in compliance with the terms of this Licence and is used only by persons who have been authorised in writing by the Licensee to do so and that such persons are made aware of, and of the requirement to comply with, the terms of this Licence.

Access and Inspection

13. The Licensee shall permit a person authorised by Ofcom:

(a) to have access to the Radio Equipment; and

(b) to inspect this Licence and to inspect, examine and test the Radio Equipment,

at any and all reasonable times or, when in the opinion of that person an urgent situation exists, at any time to ensure the Radio Equipment is being used in accordance with the terms of this Licence.

Modification, Restriction and Closedown

14. A person authorised by Ofcom may require the Radio Equipment or any part thereof, to be modified or restricted in use, or temporarily or permanently closed down immediately if in the opinion of the person authorised by Ofcom:

(a) a breach of a term of the Licence has occurred; and/or

(b) the use of the Radio Equipment is causing or contributing to interference to the use of other authorised radio equipment.

15. Ofcom may require any of the wireless telegraphy stations or wireless telegraphy apparatus that comprise the Radio Equipment to be modified or restricted in use, or temporarily closed down either immediately or on the expiry of such period as may be specified in the event of a national or local state of emergency being declared. Ofcom may only exercise this power after a written notice is served on the Licensee or a general notice applicable to holders of a named class of Licence is published.

Interpretation

16. In this Licence:

(a) the establishment, installation and use of the Radio Equipment shall be interpreted as establishment and use of stations and installation and use of apparatus for wireless telegraphy as specified in section 8(1) of the Act;

(b) the expression ”interference” shall have the meaning given by section 115 of the Act;

(c) the expressions “wireless telegraphy apparatus” and “wireless telegraphy station” shall have the meanings given by section 117 of the Act;

(d) “mobile satellite component” shall mean all elements required to provide a mobile satellite service and shall include the space station or stations required to provide the mobile satellite service and any gateway earth stations required for the delivery of mobile satellite services;

(e) “space station” shall mean a station located on an object which is beyond, is intended to go beyond or has been beyond, the major portion of the earth’s atmosphere;

(f) “station” shall mean one or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service”;

(g) The schedule(s) to this Licence form(s) part of this Licence together with any subsequent schedule(s) which Ofcom may issue as a variation to this Licence at a later date.

(h) The Interpretation Act 1978 shall apply to the Licence as it applies to an Act of Parliament.

Issued by Ofcom

Signed by

For the Office of Communications

Draft Schedule for 2170-2200 MHz

THIS DRAFT SCHEDULE PROVIDES AN EXAMPLE OF A LICENCE SCHEDULE IN RESPECT OF THE 2170-2200 MHz BAND.

SCHEDULE [1] TO LICENCE NUMBER: xxxxxx

Schedule Date: **xx xxxxx 20xx**
Licence Category: **NETWORK ACCESS [XXXX – XXXX MHz]**

1. The Licensee may establish and use

Radio Equipment at the location(s) specified in Schedule 2 for the purpose of providing Wireless Telegraphy.

2. Description of Radio Equipment Licensed

In this Licence, the Radio Equipment means the base stations (base transceiver stations or repeater stations) forming part of the Network (as defined in paragraph 3 below) that transmit in accordance with the requirements of paragraphs 8 – 12 of this schedule.

3. Purpose of the Radio Equipment

The Radio Equipment shall form part of a radio telecommunications network ("the Network"), in which Mobile Earth Stations or User Stations which meet the appropriate technical performance requirements as set out in the relevant Wireless Telegraphy (Exemption) Regulations made by Ofcom communicate by radio with the Radio Equipment to provide services as part of a mobile satellite system.

The Network shall constitute an integral part of a mobile satellite system; it shall be controlled by that satellite's radio spectrum management resource and Network management mechanism.

4. Interface Requirements for the Radio Equipment use

Use of the Radio Equipment shall be in accordance with the following Interface Requirement:

IRxxxx "Spectrum Access xxxxxxxxxxx"

5. Special Conditions relating to the Operation of the Radio Equipment

During the period that this Licence remains in force, unless consent has otherwise been given by Ofcom, the Licensee shall compile and maintain accurate written records of:

(i) the following details relating to the base stations:

a) postal address (including post code);

b) National Grid Reference, (to 100 metres resolution);

c) antenna height (above ground level) and type, bearing east of true north;

d) radio frequencies which the Radio Equipment is able to use and radio frequencies which the Radio Equipment uses;

e) the technical characteristics of the Radio Equipment both in terms of transmission and reception of wireless telegraphy;

and the Licensee must produce these records if requested by a person authorised by Ofcom.

a) The Licensee shall inform Ofcom of the address of the premises at which this Licence and the information detailed at sub-paragraph 4(c) shall be kept.

b) The Licensee must submit to Ofcom copies of such parts of the records detailed in sub-paragraph 4(c) at such intervals as Ofcom shall notify to the Licensee. Without prejudice to any information which Ofcom is required by law to publish or disclose, Ofcom may, from time to time, publish such extracts of this information as it sees fit, regarding-

(i) the total number of base stations of the Radio Equipment which are operational;

(ii) the locations, aggregated by outward postcode, of those base stations;

(ii) the frequencies used by the Radio Equipment.

c) The Licensee must also submit to Ofcom in such manner and at such times, all information relating to the establishment, installation or use of the Radio Equipment, whether stored in hard copy or electronic form, as reasonably requested for the purposes of verifying compliance with this Licence, for statistical purposes and more generally for the purpose of ensuring that Ofcom can perform its spectrum management functions.

d) The Licensee must submit to Ofcom an annual compliance report indicating that the use of Radio Equipment is in accordance with the following conditions of its licence:

(i) the Radio Equipment constitutes an integral part of a mobile satellite system and is controlled by the satellite resource and network management mechanism; it uses the same direction of transmission and the same portions of frequency bands as the associated mobile satellite component;

(ii) independent operation of the Radio Equipment, in case of failure of the mobile satellite component associated with the Radio Equipment has not exceeded 18 months.

6. National Co-ordination (e.g. at Frequency and Geographical Boundaries)

The Radio Equipment shall be operated in compliance with such co-ordination procedures as may be necessary and notified to the Licensee by Ofcom.

CGC base stations are not permitted to operate within 8km of the following sites:

a) Oakhanger (SU 776 357);

b) Colerne (ST 808 717);

Menwith Hill (SE 209 561).

7. International Cross-border Co-ordination

The Licensee must ensure that the Radio Equipment is operated in compliance with such cross-border co-ordination and sharing procedures as may be notified to the Licensee by Ofcom.

8. Permitted Frequencies

Subject to the out-of-block emissions permitted under paragraph 9, the Radio Equipment must only transmit in the following frequency band the "permitted assigned frequency block":

(i) The Radio Equipment shall transmit in the following band *[assignment, or subset, given by the Decision No 626/2008/EU process in the 2170-2200MHz band]* – Base Transmit "the downlink";

(ii) The Radio Equipment shall receive in the following band *[assignment, or subset of, given by the Decision No 626/2008/ECprocess in 1980-2010* MHz band*]* – Base Receive "the uplink".

9. Maximum Permissible Transmitted Power

The maximum mean power transmitted in the permitted assigned frequency block shall not exceed the more stringent of:

- 62 dBm/5 MHz EIRP
- 55 dBm/MHz EIRP

The power limits above apply within the frequency range 2170-2200 MHz. Outside of the permitted assigned frequency block the permissible out-of-block emissions requirement will apply (see below).

Where technologies are deployed that actively transmit in bursts then the above limits shall be applied to the active part of the transmission.

10. Permissible out-of-block emissions

The permissible out-of-block emission limit for the downlink use of frequencies is provided in the Table below:

Offset from relevant block edge	**Maximum mean EIRP for out-of-block emissions**
-1.5 to -10 MHz (lower block edge)	+3.5 dBm/MHz
-1 to –1.5 MHz (lower block edge)	-9.5 dBm/30 kHz
–1 to –0.2 MHz (lower block edge)	Linear from -9.5 dBm/30 kHz to +2.5 dBm/30 kHz
–0.2 to 0.0 MHz (lower block edge)	+2.5 dBm/30 kHz
0.0 to +0.2 MHz (upper block edge)	+2.5 dBm/30 kHz
+0.2 to +1.0 MHz (upper block edge)	Linear from +2.5 dBm/30 kHz to -9.5 dBm/30 kHz
+1.0 to +1.5 MHz (upper block edge)	-9.5 dBm/30 kHz
+1.5 to +10 MHz (upper block edge)	+3.5 dBm/MHz

Where:

- frequency offset is from the relevant block edge (in MHz);
- the lower block edge is the lower frequency of the “permitted assigned frequency block”; and
- the upper block edge is the upper frequency of the “permitted assigned frequency block”.”

11. Application of the Maximum Permissible Transmitted Power to base stations with multiple transmit antennas

(a) In cases where the inputs to different antennas are not correlated, the maximum mean EIRP transmitted in the Permitted Frequency assignment band referred to in section 7 above is calculated from the sum of the EIRP for each separate antenna;

Note: this applies for MIMO, transmit diversity and “antenna combining” (where different transmitter channels are fed to different branches of a diversity antenna system).

(b) In cases where the inputs to different antennas or antenna elements are correlated, the maximum mean EIRP transmitted in the Permitted Frequency Blocks referred to in section 7 above is calculated as follows:

$$EIRP_{effective} = \Sigma P_{nom} \text{ (dBm)} + 10 \log 180/\theta + 10 \log 360/\varphi$$

Where:

ΣP_{nom} is the sum of the nominal maximum powers of the transmitter outputs feeding each element, measured at the antenna port;

Θ is the -3 dB beamwidth of the antenna array in the vertical plane (if this beamwidth can vary, the minimum value should be used); and

φ is the angle in the horizontal plane for which the antenna system is intended to provide service (e.g. for an antenna system that is intended to provide 360° coverage with four arrays, this angle would be 90°).

Note: this applies to adaptive or beam forming antenna arrays where, averaged over time, the power radiated by the antenna system is spread evenly over its angle of operation (where this is not the case the calculation method in (a) above applies).

12. Interpretation of terms in this Schedule

In this Schedule:

(a) "EIRP" means the equivalent isotropic radiated power. This is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain);

(b) “dBm” means the power level in decibels (logarithmic scale) referenced against 1milli-Watt (i.e. a value of 0 dBm is 1 milli-Watt);

(c) “out-of-block emissions” means radio frequency emissions generated by the Radio Equipment and radiated into the frequency bands adjacent (in terms of frequency) to the licensee’s Permitted Frequency Assignment;

(d) “uplink” refers to transmissions from Mobile Earth stations or User stations to a base station or space station;

(e) “downlink” refers to transmissions from a base station or space station to a Mobile Earth Station or User station;

(f) “The expression “mobile satellite systems” shall mean electronic communications networks and associated facilities capable of providing radiocommunications services between a mobile earth station and one or more space stations, or between mobile earth stations by means of one or more space stations, or between a mobile earth station and one or more complementary ground components used at fixed locations. Such a system shall include at least one space station;

(g) "complementary ground components" of mobile satellite systems shall mean ground based stations used at fixed locations, in order to improve the availability of the mobile satellite service in geographical areas within the footprint of the system's satellite(s), where communications with one or more space stations cannot be ensured with the required quality;

(h) “base station”, means any station that is providing communications services to associated Mobile Earth Stations or User stations and forms part of an electronic communications network;

(i) “mobile earth station” shall mean an earth station in the mobile satellite service intended to be used while in motion or during halts at unspecified points”

(j) “space station” shall mean a station located on an object which is beyond, is intended to go beyond or has been beyond, the major portion of the earth’s atmosphere;

(k) “station” shall mean one or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service”;

(l) “mobile satellite component” shall mean the space station or stations required and any earth stations required to support services provided over the mobile satellite system;

(m) “earth station” shall mean a station located either on the Earth’s surface or within the major portion of the Earth’s atmosphere and intended for communication.

(n) “a satellite resource and network management mechanism” means a facility which assigns frequencies to terminals within the mobile satellite system.

Schedule 2

Licence No.		Licence version date		Payment interval	

Station details

Station ID	Station NGR	Station Address

Annex 8

Glossary

Administration	Any governmental department or service responsible for discharging the obligations undertaken in the Constitution of the ITU, in the Convention of the ITU and in the Administrative Regulations.
AIP	Administered incentive pricing – setting charges for spectrum holdings to reflect the value of the spectrum in order to promote efficient use of the spectrum.
Allocation	Use of a frequency band. Entry in the table of frequency allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radio communications services or the radio astronomy service under specified conditions. This term is also applied to the frequency band concerned.
Assignment	Use of a radio frequency or radio frequency channel. Authorisation given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions.
CEPT	European Conference of Postal and Telecommunications Administrations. A body of national policy-makers and regulators in the telecoms and postal sectors which co-operate on regulatory and technical standardisation issues, including harmonisation within their field of responsibility.
CGC	Complementary Ground Component. A terrestrial network which forms as integral part of a MSS system and uses the same frequencies, in the same direction as the satellite and which does not increase the spectrum demands of the MSS system.
COCOM	Communication Committee of the European Commission. Its members are EU Member States and it assists the Commission in carrying out its executive powers at the top level. It provides a platform for an exchange of information on market developments and regulatory activities.
Concurrent	(Of spectrum trading) a transaction in which rights and obligations are transferred while continuing to be rights and obligations of the transferor.
EC	European Commission. The executive body of the European Union.
ECC	Electronic Communications Committee. One of two committees at the highest level of CEPT which deals with all matters relating to electronic communications.
ERC	European Radiocommunications Committee, a previous committee within CEPT, the responsibilities of which are now undertaken by the ECC.

Exemption	Exemption regulations made by Ofcom allow anyone to use specified radio equipment without the need to have a WT Act licence.
Frequency Band	A defined range of frequencies that may be allocated for a particular radio service, or shared between radio services.
FSS	Fixed Satellite Service. A Satellite service which provides communications between fixed earth stations.
Geo-synchronous orbit	An orbit around the earth that is at a distance which results in it orbiting at the same speed and direction as the earth spins on its axis.
GHz	Gigahertz – unit of frequency equal to one thousand MHz.
GSO	Geostationary satellite orbit. A geo-synchronous orbit of the earth, directly above the equator, in which the satellite appears to be stationary when viewed from earth.
Harmonisation	The identification of common frequency bands throughout a region (e.g. Europe) for a particular application and, in some cases, technology.
Hz	Basic unit of frequency – one hertz is equivalent to one cycle per second.
Interference	Unwanted disturbance caused in a radio receiver or other electrical circuit by electromagnetic radiation emitted from an external source.
ITU	International Telecommunication Union - the United Nations agency for information and communication technology responsible for developing and publishing the International Radio Regulations.
JPT	Joint Project Team.
Market mechanisms	Approach to managing spectrum where key decisions, e.g. on acquiring or disposing of spectrum and what service to provide are made by spectrum users rather than by the regulator.
MSS	An RSC Decision definition of 'systems providing mobile satellite services': systems capable of providing Radiocommunications services between a mobile earth station and one or more space stations, or between mobile earth stations by means of one or more space stations, or between a mobile earth station and one or more complementary ground based stations used at fixed locations.
MSS	An ITU definition of a Mobile Satellite Service: a Radiocommunications service between mobile earth stations and one or more space stations or between space stations used by this service; or between mobile earth stations by means of one or more space stations. This service may also include Feeder links necessary for its operation.
MHz	Megahertz – unit of frequency equal to one million Hz.
Ofcom	Office of Communications. Ofcom is the regulator for the UK communications industries, with responsibilities across television, radio, telecommunications and wireless communications services.

Opportunity cost	The cost of a decision or choice in terms of the benefits which would have been received from the most valuable of the alternatives that was foregone.
Outright	(Of spectrum trading) a transaction in which the transferred rights and obligations pass to the transferee and no longer appertain to the transferor.
Partial	(of spectrum trading) a transaction in which some of the rights and obligations are transferred while others are not.
PMSE	Programme Making and Special Events – a class of radio application that supports a wide range of activities in entertainment, broadcasting, news gathering and community events.
Radio Regulations	International Radio Regulations made by the ITU, which have the status and force of a treaty, allocate frequencies globally to various applications and deal with cross-border interference.
Radio spectrum	The portion of the electromagnetic spectrum below 3000 GHz that is used for radiocommunications.
RSC	Radio Spectrum Committee of the EC, made up of EU. administrations and which assists the EC in the adoption of technical implementing measures in support of Community policies.
Satellite	An object which is located in an orbit around a celestial body. In Radiocommunications, a man-made electronic device which receives and transmits signals to and from earth stations on the earth's surface.
Spectrum	The range of electromagnetic radio frequencies from LF frequencies to x-rays and gamma rays.
Spectrum liberalisation	Removal of restrictions from WT licences and RSA to allow holders greater flexibility to change how they use spectrum.
Spectrum trading	Ability of spectrum users to transfer rights and obligations under WT licences to another person in accordance with regulations made by Ofcom. Trades may be total, partial, outright or concurrent.
Total	(Of spectrum trading) a transaction in which all the rights and obligations are transferred to the transferee.
UKFAT	UK Frequency Allocation Table. This identifies responsibilities for the management of frequency bands or services showing whether they are managed by Ofcom, the MOD or another Government department or Agency. It also includes the ITU Table of Frequency Allocations contained in the current Radio Regulations. It is published by Ofcom on behalf of the National Frequency Planning Group, a sub-committee of the UKSSC.
UKSSC	Cabinet Office committee that discusses matters relating to the use of the radio spectrum, including by government departments and other public sector bodies.
WRC	A World Radiocommunication Conference, one of the principal activities of the ITU Radiocommunication Sector (ITU-R), is convened normally every three to four years to consider specific

	radiocommunication matters. A World Radiocommunication Conference deals with those items which are included in its agenda, including the partial or, exceptionally, complete revision of the Radio Regulations.
WT Act	The Wireless Telegraphy Act 2006, which sets out the statutory framework for management of the radio spectrum consolidating a number of older Acts dating back to 1949.
WT licence	Licence granted by Ofcom to authorise installation or use of radio equipment as required by section 8(1) of the WT Act.