



ECC Report **279**

The Use of Earth Stations In-Motion (ESIM) operating to
NGSO Satellite Systems in the 10.7-12.75 GHz and 14-
14.5 GHz Band

Approved 18 May 2018

0 EXECUTIVE SUMMARY

NGSO FSS satellite systems operating in the 10.7-12.75 GHz (referred to as 11 GHz band) and 14-14.5 GHz (referred to as 14 GHz band) are to be deployed in Europe, as a part of its worldwide deployment, by 2019. Fixed earth stations and Earth Stations in-Motion (ESIM) will operate to such satellite system. Such ESIM may be deployed with land, maritime and aeronautical based applications. This Report examines the regulatory issues, including authorisation, relating to the deployment of ESIM with NGSO satellite systems operating in the 11 GHz and 14 GHz (11 and 14 GHz collectively referred to as “Ku-band” in this Report).

ESIM operating to Ku-band NGSO FSS satellite systems are generally expected to be deployed ubiquitously throughout the CEPT. The frequency band 14-14.5 GHz is available in most CEPT administrations on an exclusive basis for satellite use. However, in a limited number of CEPT administrations other services are deployed within the 11 GHz and 14 GHz bands, and this will require Ku-band NGSO FSS satellite systems and ESIM operating to such satellite systems to maintain compatibility with other services. Recognising this situation, CEPT conducted extensive technical studies and the findings are recorded in ECC Report 271 [1]. ECC Report 271 identified other services deployed within these bands as follows:

- 10.6-10.7 GHz: the radio astronomy service and the earth exploration-satellite service (passive), including the passive band 10.68-10.7 GHz. The protection of these services from out of band emissions of satellites deployed with Ku-band NGSO FSS satellite systems;
- 14.25-14.5 GHz: the Fixed Service (FS) is deployed in a limited number of CEPT administrations. Protection of FS from emissions from ESIM (land, maritime and aeronautical) is considered;
- 14.47-14.5 GHz: the radio astronomy service (RAS) is deployed in a limited number of CEPT administrations. Protection of RAS from emissions from ESIM (land, maritime and aeronautical) is considered.

The ECC Report 271 [1], following a detailed analysis, identified the technical measures for maintaining compatibility between ESIM and other services in the frequency bands concerned. In the case of land and maritime ESIM the compatibility is maintained by ceasing transmissions in the frequency bands overlapping the frequency assignments of FS and RAS stations within defined protection zones. In the case of aeronautical ESIM the compatibility is maintained by meeting certain Power Flux Density (PFD) levels on Earth. The ECC Report 271 also identified the maximum e.i.r.p. value that ensures High Intensity Radiated Field (HIRF) aircraft protection for such earth stations.

ECC Report 271 identified that the management of interference to the RAS and the Earth Exploration-Satellite Service (EESS) in the band adjacent to the satellite downlink in 10.7-12.75 GHz could be achieved by careful satellite design and suppressing satellite transmissions in the channel immediately adjacent to 10.7 GHz.

This ECC Report provides the regulatory framework for the deployment of ESIM within the CEPT.

It is noted that some administrations issue individual licences to maritime and/or aeronautical ESIM in order to comply with their national regulations.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications Administrations
CRAF	Committee on Radio Astronomy Frequencies
ECC	Electronic Communications Committee
EESS	Earth Exploration-Satellite Service
EFIS	ECO Frequency Information System
e.i.r.p.	Equivalent isotropically radiated power
ESIM	Earth Stations In-Motion
ESOMP	Earth Stations on Mobile Platforms
ESV	Earth Stations onboard Vessel
FS	Fixed Service
FSS	Fixed-Satellite Service
GSO	Geostationary Satellite Orbit
HIRF	High Intensity Radiated Field
ITU	International Telecommunications Union
NCF	Network Control Facility
NGSO	Non-Geostationary Satellite Orbit
PFD	Power Flux Density
RAS	Radio astronomy service
TDMA	Time Division Multiple Access
WRC	World Radiocommunication Conference

1 INTRODUCTION

This ECC Report presents technical, operational and regulatory requirements that are relevant to the authorisation of Earth Stations In-Motion (ESIM) operating with non-geostationary fixed-satellite service (FSS) satellite systems in the frequency bands 10.7-12.75 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space) allocated to the fixed-satellite service. ESIM considered in the Report are to be deployed for land, maritime and aeronautical applications. The frequency bands identified are generally referred to as “Ku-band”. There are other radio services authorised within this Ku-band in several CEPT administrations. This ECC Report proposes a regulatory framework that would allow ESIM to be deployed, in particular their transmissions in the 14.0-14.5 GHz band, without causing harmful interference to other authorised services.

These NGSO satellite systems, with access to broader bandwidths, provide a range of communications services with the main provision being broadband communication services. An ESIM working to these NGSO satellite systems could also function as a base station, providing a small cell of a cellular network, with an integrated satellite backhaul. Such small cells extend cellular mobile networks to underserved or unserved parts of the world. NGSO satellite systems may be deployed in various satellite orbit configurations to provide coverage over a specific part of the world or to offer worldwide coverage. Worldwide continuous coverage is available from satellites deployed in polar orbits and in multiple of planes sufficient for worldwide coverage. One such NGSO satellite system that intends to provide worldwide coverage is OneWeb, and the OneWeb system will deploy 720 satellites in 18 polar orbital planes at an attitude of 1200 km. OneWeb NGSO satellite service is expected to be available in Europe, as a part of a worldwide system, in 2019.

ESIM working to FSS NGSO satellite systems may be operated on land, on vessels at sea and on aircrafts. ESIM on land are designed for ubiquitous deployment, whereas ESIM on vessels and aircrafts are to be deployed complying with the relevant requirements. Such deployments, specifically the ubiquitous deployments on land, offer tremendous advantage to users throughout the CEPT, whether they are in regions well served or underserved by broadband offered by other means.

The CEPT has a long history of providing suitable regulatory frameworks for licensing of earth stations for innovative services deployed within the CEPT. The primary consideration has always been given to the transmissions from earth stations in order to ensure that such transmission from earth stations maintain the necessary compatibility with other services authorised by administrations. The protection of an earth station from interference from other services is generally afforded with necessary frequency coordination. In other cases such reception will be on the basis of no protection. These NGSO satellite systems will work on the latter basis, seeking no protection for its receivers. The CEPT also established regulatory framework for Earth Stations On Mobile Platforms (ESOMP)¹, providing for designation of the frequency bands utilised by such satellite systems, exemption from individual licensing and their free circulation and use. This regulatory framework was established with ECC Decisions ECC/DEC/(13)01 [2] for Ka-band GSO ESOMPs and ECC/DEC/(15)04 [3] for Ka-band NGSO ESOMPs. These regulatory frameworks specified the technical conditions for maintaining compatibility with other services. The technical conditions for such compatibility were established following detailed technical studies carried out by the CEPT.

This Report identifies the regulatory framework necessary for authorising ESIM working to Ku-band FSS NGSO satellite systems, taking into account the conclusions of the technical studies carried out by the CEPT on compatibility between ESIM and other authorised services. These technical studies are given in ECC Report 271 [1]. The regulatory framework discussed in this Report are for the designation of frequency bands for ESIM, their authorisation on the basis of exemption from individual licensing and their free circulation and use. This Report also gives consideration to the cases where individual licences are needed for maritime and aeronautical ESIM deployments in some administrations because of obligations placed by the national regulations.

¹ The term ESOMP was changed to Earth Station in-Motion (ESIM) during discussions at WRC-15

The general focus of the technical and regulatory considerations is on the use of 14-14.5 GHz, the band used for ESIM transmissions, and the resulting compatibility situations. However, following a decision taken by the CEPT, these studies also examined the potential interference from out of band emissions from satellite down link in the 10.7-12.5 GHz into the radio astronomy and earth exploration-satellite services in the 10.6-10.7 GHz band. The conclusions of technical studies are offered in ECC Report 271 [1], and their salient points are reproduced in this Report. Such studies, as ECC Report 271 stated, require specific characteristics of NGSO satellite systems, and to this end ECC Report 271 used the system characteristics of one Ku-band NGSO system called OneWeb.

This Report will be used as the basis for the preparation of an ECC Decision on authorisation of ESIM working to Ku-band GHz NGSO FSS satellite systems.

2 OPERATION OF ESIM IN THE BANDS 10.7-12.75 GHZ (SPACE-TO-EARTH) AND 14.0-14.5 GHZ (EARTH-TO-SPACE) AND OTHER DEPLOYMENTS IN THE 14.0-14.5 GHZ BAND WITHIN THE CEPT

The 10.7-12.75 GHz band is used for space-to-Earth links of ESIM. The use of these frequencies is not the subject of this Report and therefore not considered further, except for the consideration of compatibility between FSS NGSO satellite systems and the radio astronomy service (RAS) and the earth exploration-satellite service (EESS) in the 10.6-10.7 GHz band.

The 14.0-14.5 GHz band is used for Earth-to-space links of ESIM, i.e. the transmissions from ESIM. The use of this band by FSS NGSO satellite systems will be examined in detail in this Report.

2.1 NGSO ESIM DOWNLINK IN THE 10.7-12.75 GHZ BAND

The use of the band 10.7-12.75 GHz is used for the downlink of the NGSO satellite systems. The CEPT considered that out of band emissions from the downlink into RAS and EESS in the 10.6-10.7 GHz should be assessed to ensure the protection of RAS and EESS. ECC Report 271 [1] has provided necessary assessment of this interference situation.

ECC Report 271 [1] has stated that the assessments on out of band interference into RAS and EESS require specific characteristics of the NGSO satellite systems and cannot be done on the basis of generic NGSO systems. ECC Report 271 has provided such an assessment based on the OneWeb NGSO satellite system.

2.2 NGSO ESIM UPLINK IN THE 14.0-14.5 GHZ BAND

ESIM may be operated on land based vehicles or trains with a roof top mounted antenna, or onboard a vessel, and onboard an aircraft with an antenna mounted on top of the fuselage. The compatibility between these ESIM and others services will determine the way the ESIM could be authorised within the CEPT.

ECC Report 271 has carried out technical assessments to determine the compatibility between ESIM and other services using agreed protection criteria of other services. In some cases, where specific system characteristics of ESIM working to NGSO satellite systems were required ECC Report 271 has used the system characteristics of the OneWeb system.

Deployment of ESIM within Europe will be subject to the Radio Equipment Directive (2014/53/EU) [4]. Accordingly, ESIM, will be required to comply with the ETSI standard EN 303 980 "Harmonised standard for fixed and earth stations in-motion communicating with non-geostationary satellite systems (NEST) in the 11 GHz to 14 GHz frequency bands covering essential requirements of article 3.2 of the Radio Equipment Directive 2014/53/EU" [4]. ECC Report 271 has noted that such compliance, specifically the compliance with the specification in the clause 4.2.6.2.2 of EN 303 980 is essential for maintaining compatibility with other services. The clause 4.2.6.2.2 of EN 303 980 requires the transmissions from ESIM to be controlled by the network control facility (NCF) of the satellite system, thus allowing the NCF to control the cessation of such transmissions, taking into account, amongst others, the locations of the ESIM. This clause of the EN 303 980 also places a specific requirement on the cessation of transmissions of ESIM as ESIM enter areas where ESIM transmissions are not authorised.

2.3 FREQUENCY ALLOCATIONS WITHIN THE 14.0-14.5 GHZ BAND

Frequency allocations within the 14.0-14.5 GHz band as given the Radio Regulations [6] are shown in Table 1.

Table 1: Allocations given in the EFIS² for the band 14-14.5 GHz [6]

Frequency band	Allocations
14 GHz-14.25 GHz (5.504)	Space Research Mobile-Satellite (Earth-to-space) (5.504B) (5.504C) (5.506A) FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A) (5.457B) (5.484A) (5.506) (5.506B)
14.25 GHz-14.3 GHz (5.504)	FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A) (5.457B) (5.484A) (5.506) (5.506B) Space Research Mobile-Satellite (Earth-to-space) (5.504B) (5.506A) (5.508A)
14.3 GHz-14.4 GHz	Mobile-Satellite (Earth-to-space) (5.504B) (5.506A) (5.509A) FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A) (5.457B) (5.484A) (5.506) (5.506B)
14.4 GHz-14.47 GHz (5.504A)	FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A) (5.484A) (5.506) (5.457B) (5.506B) Mobile-Satellite (Earth-to-space) (5.504B) (5.506A) (5.509A)
14.47 GHz-14.5 GHz (5.149) (5.504A)	FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A) (5.484A) (5.506) (5.457B) (5.506B) Mobile-Satellite (Earth-to-space) (5.504B) (5.506A) (5.509A) Radio Astronomy

Studies undertaken by the CEPT [1] have shown that services deployed within the CEPT in the band 14-14.5 GHz, other than fixed-satellite service and mobile satellite service, are limited to the following:

- 14.25-14.5 GHz: Fixed Service
- 14.47-14.5 GHz: radio astronomy service

Fixed service: the same studies [1] reported that five CEPT administrations have declared fixed links deployments within the 14.25-14.5 GHz band when responding to a CEPT survey, and it is also noted that one administration identified the heavy use of 15 GHz band with channel arrangement starting at 14.4 GHz.

Radio astronomy service: The same studies [1] report that six CEPT administrations utilise the band 14.47-14.5 GHz for radio astronomy observations with a total number of observatories (i.e. stations) limited to about seven. Committee on Radio Astronomy Frequencies (CRAF) provides up to date information on stations carrying out observations in this band.

For a long time, the CEPT has recognised the importance of the band 14.0-14.5 GHz for satellite services for ubiquitous deployment of earth stations. With this recognition CEPT recommended (Recommendation ERC/REC 13-03 [7]) that fixed links deployed within the band 14.25-14.5 GHz should be migrated from this band. Most CEPT administrations have implemented this recommendation. However, five administrations continue to operate fixed links in this band.

² www.efis.dk

3 COMPATIBILITY BETWEEN ESIM AND STATIONS OF OTHER SERVICES

ECC Report 271 [1] examined the compatibility between ESIM and the fixed and radio astronomy services operating within the band 14.0-14.5 GHz. The results of these compatibility studies are summarised in the following sections.

3.1 COMPATIBILITY WITH THE FIXED SERVICE IN THE 14.25-14.5 GHZ BAND

Table 2 lists the compatibility requirements to protect fixed service links from ESIM. The table shows a generic case (where compatibility requirements are applicable to any Ku-band NGSO FSS ESIM) and the specific case where the compatibility requirements are established specifically for ESIM operating to the OneWeb NGSO satellite system.

Table 2: Compatibility requirements for the protection of fixed service links

ESIM Operation	Compatibility requirements Generic ESIM	Compatibility requirements OneWeb ESIM
Land	<p>The compatibility between land ESIM and fixed links of the FS is achieved by ensuring that the interference power received at the fixed link receiver resulting from land ESIM transmissions does not exceed the limit established for the protection of the fixed link receiver. This requires the land ESIM to maintain a certain separation distance from the fixed link receiver when transmitting in frequency bands overlapping the frequency band used by the fixed link.</p> <p>The contour created by separation distances around the FS receiver in all azimuths, at which the protection criteria are met for given land ESIM transmissions, establishes the protection zone.</p> <p>Protection is afforded to FS by land ESIM ceasing transmission in the frequency bands overlapping the frequency band used by the fixed link within the protection zone. This cessation of transmissions from land ESIM will be carried out by the NGSO satellite system using the control of emission function, described in the ETSI standard EN 303 980 [4] (see Section 2.2 above).</p> <p>It is recommended in the ECC Report 271 [1] that the protection zone for a fixed receiver should be determined on a case by case basis using the methodology given in that report. Such derivation should take into account the specific characteristics of the fixed links as well as the actual terrain profile associated with the fixed link.</p> <p>Alternatively, a PFD limit of -116 dBW/m²/MHz at 30m height above ground at the FS receiver has been established as the protection requirement for fixed service receivers, but it would only apply in the FS main beam.</p>	<p>Compatibility between OneWeb land ESIM and FS could be achieved as described for the generic ESIM case.</p> <p>Example calculations carried out using the characteristics of OneWeb land ESIM and a typical fixed link receiver have established that OneWeb land ESIM should maintain a maximum separation distance of 77 km in the main beam direction and a separation distance of 11 km in other directions from the FS receiver in order to achieve compatibility with the fixed service receiver.</p>

ESIM Operation	Compatibility requirements Generic ESIM	Compatibility requirements OneWeb ESIM
Maritime	<p>The compatibility between maritime ESIM and a fixed link is achieved by ensuring that the interference power received at the fixed link receiver resulting from ESIM transmissions does not exceed the limit established for the protection of the fixed link receiver. This requires the maritime ESIM to maintain a certain separation distance from the fixed link receiver. The methodology used is exactly the same as for Earth Stations onboard Vessel (ESV) in the same band.</p> <p>The contour created by separation distances between the maritime ESIM and the fixed receiver in all azimuths, at which protection criteria are met for given maritime ESIM transmissions, establishes the protection zone.</p> <p>Protection is afforded to FS by maritime ESIM ceasing transmission in the frequency bands overlapping the frequency band used by the fixed link within the protection zone. This cessation of transmissions from maritime ESIM will be carried out by the NGSO satellite system using control of emission function, described in the ETSI standard EN 303 980 [4] (see Section 2.2 above).</p> <p>It is recommended in the ECC Report 271 [1] that the protection zone for a fixed receiver should be determined on a case by case basis using the methodology given in that report and in the Recommendation ITU-R SF.1650 [8].</p> <p>Alternatively, a PFD limit of -116 dBW/m²/MHz at 80m height above the sea level at the shore has been established as the protection requirement for fixed service.</p>	<p>Compatibility between OneWeb maritime ESIM and FS could be achieved as described for the generic ESIM case.</p> <p>Example calculations performed using the characteristics of OneWeb maritime ESIM and fixed link receiver have established that a maritime ESIM located at the shore (i.e. with no separation from the shore) would protect the FS receiver.</p>
Aeronautical	<p>The PFD mask derived for the OneWeb satellite system (see right column) could be applied to any NGSO satellite system using Time Division Multiple Access (TDMA) access method.</p> <p>If the NGSO satellite system uses other access methods, such as CDMA, the PFD mask has to be re-established using the methodology given in ECC Report 271 [1].</p> <p>The deployment of airborne ESIM should ensure that this PFD criterion on Earth is met to protect FS links.</p>	<p>Calculations carried out using the characteristics of OneWeb NGSO satellite system and its airborne ESIM have led to the PFD mask on Earth (given below) to be met by airborne ESIM in order to protect FS:</p> <p>-122 dB(W/(m² · MHz)) for $\theta \leq 5^\circ$ -127 + θ dB(W/(m² · MHz)) for $5^\circ < \theta \leq 40^\circ$ -87 dB(W/(m² · MHz)) for $40^\circ < \theta \leq 90^\circ$</p> <p>where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).</p>

It should be noted that a key element for maintaining compatibility with fixed service for land and maritime ESIM is the ability of the ESIM to suppress transmissions in the relevant frequency bands when the ESIM is within a protection zone. In the case of airborne ESIM, limiting its PFD on Earth to the values specified above provides for the necessary compatibility with fixed service links.

3.2 COMPATIBILITY WITH RADIO ASTRONOMY SERVICE

Table 3 lists the compatibility requirements to protect radio astronomy service from ESIM. The table shows a generic case (where the criterion is applicable to any Ku-band NGSO FSS ESIM) and the specific case where the compatibility requirements are established specifically for ESIM operating to OneWeb NGSO satellite system.

Table 3: Compatibility requirements for the protection of radio astronomy

ESIM operation	Compatibility requirements	Compatibility requirements
	Generic ESIM	OneWeb ESIM
Land	<p>The compatibility between land ESIM and RAS is achieved by ensuring that the PFD at the RAS station resulting from the land ESIM transmissions does not exceed the limit established for the protection of RAS observations. This requires the land ESIM to maintain a certain separation distance from the RAS station.</p> <p>The protection criterion of RAS is given as a PFD value at the observatory of $-169 \text{ dBW/m}^2/150 \text{ kHz}$ at the observatory, not to be exceeded more than 2% of the time (Ref: Recommendation ITU-R RA.769)</p> <p>The contour created by separation distances around the observatory in all azimuths, at which PFD limit is met for given ESIM transmissions, establishes the protection zone.</p> <p>Protection is afforded to RAS by a land ESIM ceasing transmission in the frequency band 14.47-14.5 GHz (i.e. overlapping with RAS observations) within the protection zone. This cessation of transmissions from land ESIM will be carried out by the NGSO satellite system using the control of emission function, described in the ETSI standard EN 303 980 [4] (see Section 2.2 above).</p> <p>It is recommended in the ECC Report 271 [1] that the protection zone for a given RAS station should be determined on a case by case basis using the methodology given in that report. Such derivation takes into account, amongst other things the actual terrain profile associated with the RAS station.</p>	<p>Compatibility between OneWeb land ESIM and FS could be achieved as described for the generic ESIM case.</p> <p>Example calculations carried out using the characteristics of OneWeb land ESIM (with an e.i.r.p. towards the horizon of $-33 \text{ dBW}/40 \text{ kHz}$) and a radio astronomy station, have shown that the size of the protection zone can extend up to 200 km</p>
Maritime	<p>The compatibility between the maritime ESIM and RAS is achieved by ensuring that the PFD at the RAS station resulting from the maritime ESIM transmissions do not exceed the limit established for the protection of RAS observations. This requires the maritime ESIM to</p>	<p>Compatibility between OneWeb maritime ESIM and FS could be achieved as described for the generic ESIM case.</p>

ESIM operation	Compatibility requirements Generic ESIM	Compatibility requirements OneWeb ESIM
	<p>maintain a certain separation distance from the RAS station.</p> <p>The protection criterion of RAS is given as a PFD value at the observatory of -169 dBW/m²/150 kHz, not to be exceeded more than 2% of the time (Ref: Recommendation ITU-R RA.769 [8])</p> <p>The contour created by separation distances around the observatory in all azimuths, at which PFD limit is met for given ESIM transmissions, establishes the protection zone.</p> <p>Protection is afforded to RAS by maritime ESIM ceasing transmission in the frequency band 14.47-14.5 GHz (i.e. overlapping with RAS observations) within the protection zone. This cessation of transmissions from maritime ESIM will be carried out by the NGSO satellite system using the control of emission function, described in the ETSI standard EN 303 980 [4] (see Section 2.2 above).</p> <p>It is recommended in ECC Report 271 [1] that the protection zone for a given RAS station should be determined on a case by case basis using the methodology given in that report. Such derivation takes into account, amongst other things the actual terrain profile associated with the RAS station.</p>	<p>Example calculations carried out using the characteristics of OneWeb maritime ESIM (with an e.i.r.p. towards the horizon of -33 dBW/(40 kHz)) and a radio astronomy station, have shown that the size of the protection zone can extend up to 200 km.</p>
	<p>A PFD (on Earth) mask, based on the protection criteria for RAS station, could be derived for the protection of RAS station. The values of the PFD mask would depend on the NGSO system characteristics-such as the number of ESIM visible to the RAS station and simultaneously transmitting in frequency bands overlapping 14.47-14.5 GHz (for details see ECC Report 271 [1]). This number of ESIM in turn may depend many factors, such as the number of satellites visible to the aircraft at a given altitude, the type of access scheme of the NGSO FSS satellite system and the percentage of traffic carried by ESIM onboard aircraft</p> <p>In view of the above the compatibility between ESIM and each RAS station should be addressed using the specific system characteristics of the NGSO satellite system concerned.</p>	<p>Calculations carried out using the characteristics of OneWeb NGSO satellite system and its airborne ESIM have led to the PFD mask on Earth (given below) to be met by airborne ESIM in order to protect RAS observations:</p> <p>$-185 + 0.5 \cdot \theta$ dB(W/(m² · 150 kHz)) for $\theta \leq 10^\circ$ -180 dB(W/(m² · 150 kHz)) for $10^\circ < \theta \leq 90^\circ$</p> <p>where θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal).</p> <p>In view of the low levels of PFD derived for the case of OneWeb, the NGSO airborne stations may be required to cease emissions in the band 14.47-14.5 GHz when in visibility of a RAS station performing observations in this band.</p>

ESIM operation	Compatibility requirements Generic ESIM	Compatibility requirements OneWeb ESIM
		The cessation of transmissions from ESIM, performed by the NGSO satellite system by deploying the control of emission function, stipulated in the ETSI standard EN 303 980 [4] (see Section 2.2 above) will suppress the frequency band 14.47-14.5 GHz when the aircraft is in visibility of a RAS station and thereby maintain compatibility.

It should be noted that a key element of maintaining compatibility with RAS for land and maritime ESIM is the ability of the ESIM to suppress transmissions in the relevant frequencies when the ESIM is within a protection zone. In the case of airborne ESIM, unless the PFD on Earth mask established cannot be met, the airborne ESIM shall suppress the transmissions in the 14.47-14.5 GHz at all times when in visibility of a RAS station deploying the frequency band 14.47-14.5 GHz.

4 COMPATIBILITY WITH GSO NETWORKS

The Article 22.2 of the Radio Regulations [6] places a requirement for the protection of geostationary satellites networks operating in the bands 10.7-12.5 GHz and 14-14.5 GHz from unacceptable interference from NGSO satellite systems. The protection to be afforded to GSO satellite networks is stipulated in the No. 22.5C to 22.5I of Article 22 and Resolution 85.

The compliance with the relevant provisions of the Radio Regulations will be the responsibility of notifying administrations of NGSO satellite systems. Such compliance will also be assessed by the ITU at the stages of notification and bringing into use of assignments of the NGSO satellite networks.

5 COMPATIBILITY BETWEEN NGSO SATELLITE SYSTEM OPERATING IN THE BAND 10.7-12.75 GHZ AND THE RADIO ASTRONOMY SERVICE IN THE 10.6-10.7 GHZ BAND

The radio astronomy service has an allocation in the band 10.6-10.7 GHz, which are adjacent to the band 10.7-12.75 GHz used for the downlink of FSS NGSO satellite systems. The out of band emissions from the satellites of FSS NGSO satellite systems, especially those deploying a significant number of satellites, have a greater propensity to pose a significant interference environment for the radio astronomy service. This compatibility issue was studied by the CEPT and recorded in ECC Report 271 [1].

The studies carried out by the CEPT show that the likely interference to the radio astronomy service is dependent upon the specific characteristics of the satellite constellation. These studies also show the techniques that may be applied to mitigate interference could be unique to a given satellite system because each satellite system has its own design of the payload and technology specific to the system.

The CEPT studies, provided in the ECC Report 271, examined the technical characteristics and operational aspects of payloads of the OneWeb NGSO satellite system and assessed the out of band emissions in to RAS in the 10.6-10.7 GHz band.

Any other NGSO system deploying down link frequencies at the 10.7 GHz band edge should be subjected to detailed technical study to assess the protection it affords to RAS.

The CEPT studies examined the technical characteristics and the operational aspects of the payloads of OneWeb satellite system in order to assess the out of band emissions in to the 10.6-10.7 GHz band. The ECC Report 271 states that payloads of OneWeb satellites incorporate a combination of techniques which allow out of bands emissions in 10.6-10.7 GHz to meet the protection criteria of RAS with an additional margin. The unwanted emission levels derived from simulations of OneWeb satellite system, as a function of different combination of the satellite beams and the filter capabilities, result in 1.93% data loss for the Effelsberg radio astronomy station, which is below the allowed 2% data loss. The ECC Report 271 therefore has concluded that the out of band emissions of the OneWeb satellite system falling in the 10.6-10.7 GHz will meet the protection criteria of the radio astronomy service.

As for the for the frequency channel (10.7-10.95 GHz), immediately adjacent to the passive band (10.68-10.7 GHz), deployed by the OneWeb satellite system, the avoidance of interference is possible by deactivating the band when in visibility of an RAS station performing observations in this passive band.

Figure 1 shows where OneWeb's channel 10.7-10.95 GHz has to be deactivated (area marked in red) when a satellite is in visibility of a RAS station performing observations in 10.6-10.7 GHz band.

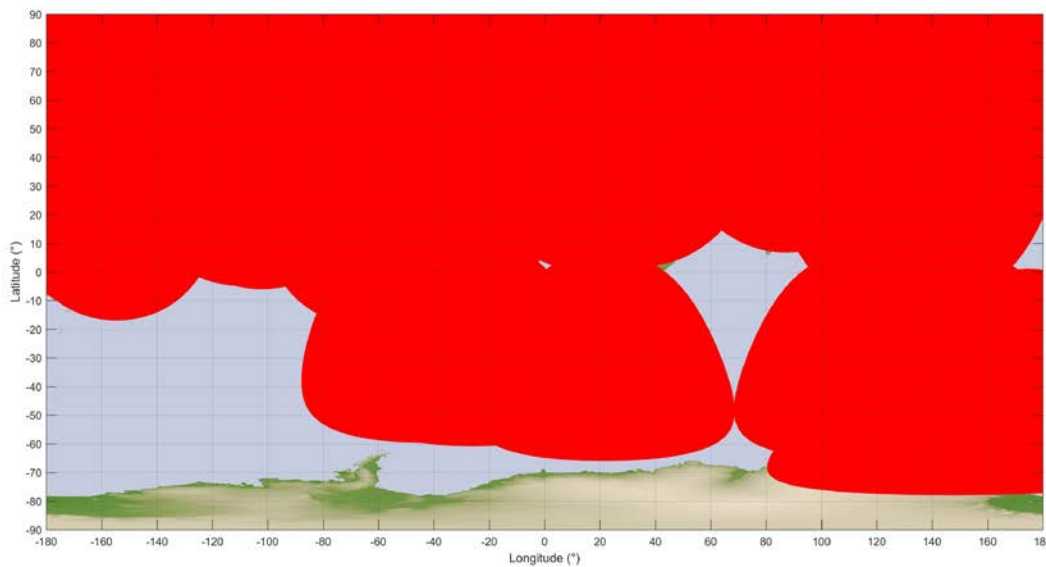


Figure 1: Visibility areas of RAS stations performing observations in the 10.6-10.7 GHz band

For a different NGSO FSS system, the particular satellite antenna characteristics should be considered in order to deduce the e.i.r.p. limitations allowing the protection RAS in the adjacent band; therefore, the results in this section are not transposable to other NGSO FSS systems. If another FSS NGSO system is considered to operate in this band, new analysis should be carried out.

Maintaining the compatibility with RAS stations has to be included in the ECC Decision for NGSO ESIM.

6 COMPATIBILITY BETWEEN NGSO SATELLITE SYSTEM OPERATING IN THE BAND 10.7-12.75 GHZ AND THE EARTH EXPLORATION-SATELLITE SERVICE IN THE 10.6-10.7 GHZ BAND

The earth exploration-satellite (passive) service has an allocation in the band 10.6-10.7 GHz, which is adjacent to the band 10.7-12.75 GHz used for the downlink of FSS NGSO satellite systems. The out of band emissions from the satellites of FSS NGSO satellite systems, especially those deploying a significant number of satellites, have a greater propensity to pose a significant interference environment for the Earth Exploration Satellite Service (EESS). This aspect was also studied by the CEPT and recorded in ECC Report 271 [1].

The studies carried out by the CEPT show that the likely interference to EESS is dependent upon the specific characteristics of the satellite constellation. These studies also show the techniques that may be applied to mitigate interference could be unique to a given satellite system because each satellite system has its own design of the payload and technology specific to the system.

The CEPT studies, provided in ECC Report 271, examined the technical characteristics and operational aspects of payloads of the OneWeb satellite system in order to assess the out of band emissions in to EESS in the 10.6-10.7 GHz band.

The frequency band 10.6-10.7 GHz is currently used by passive sensors, representing conical scan radiometers, carried onboard NGSO EESS satellites. The band 10.6-10.7 GHz is of primary interest to measure rain, snow, sea state (including sea surface temperature), and ocean wind. Typical characteristics for passive sensors operating in the band 10.6-10.7 GHz are provided in Recommendation ITU-R RS.1861 [9]. Performance and interference criteria for EESS passive sensors are provided in Recommendation ITU-R RS.2017 [11].

Studies conducted in the ECC Report 271 show that meeting the protection criterion for the protection of radio astronomy in the band 10.6-10.7 GHz leads to unwanted emission e.i.r.p. limits applied for the OneWeb satellites. Meeting these unwanted emission e.i.r.p. limits in the vicinity of EESS satellites is also sufficient for the protection of passive sensors and no additional constraint for this system would be needed to ensure compatibility with EESS (passive) in the band 10.6-10.7 GHz. As the level of filtering for the channel adjacent to the passive band (channel 1) is currently not sufficient for the OneWeb constellation, this requires either to improve filtering, or the deactivation of this channel when in visibility of the EESS (passive) satellite. If other means, apart from disabling channel one, are used to ensure protection of RAS, additional studies should be carried out to check compatibility between OneWeb and EESS (passive) systems. To identify and agree on these means, separate bilateral agreements between administrations operating NGSO FSS systems and administrations operating EESS would be required to ensure protection of the passive band 10.6-10.7 GHz.

For a different NGSO FSS system, the particular satellite antenna characteristics should be considered in order to deduce the e.i.r.p. limitations allowing the EESS protection in the 10.6-10.7 GHz band; therefore, the results in this section are not transposable to other NGSO FSS systems. If another FSS NGSO system is considered to operate in this band, new analyses should be carried out, including the aggregate effect of the NGSO and GSO systems.

Maintaining the compatibility with EESS (passive) stations has to be included in the ECC Decision for NGSO ESIM.

7 REGULATORY FRAMEWORK NEEDED FOR THE OPERATION OF FSS ESIM IN THE BANDS 10.7-12.75 GHZ (SPACE-TO-EARTH) AND 14.0-14.5 GHZ (EARTH-TO-SPACE).

FSS NGSO satellite systems are designed to offer broadband and other communications services. The ubiquitous deployment of ESIM offers tremendous benefits to users of such satellite systems. These benefits are further enhanced if the deployment of ESIM could be subjected to minimal regulatory considerations. These minimal regulatory considerations include exemption from individual licensing and free circulation and use.

Article 5 of the Authorisation Directive (Directive 2002/20/EC) [11] requires the use of spectrum to be facilitated under general authorisations, where, amongst other things, the risk of harmful interference to other radio services is negligible. The Radio Equipment Directive (2014/53/EU) [4] ensures a Single Market for radio equipment by setting essential requirements for safety and health, electromagnetic compatibility, and the efficient use of the radio spectrum. It applies to all products using the radio frequency spectrum. With the implementation of the Authorisation Directive and the Radio Equipment Directive (including its forerunner Radio and Telecommunication Terminal Equipment (R&TTE) Directive (1999/5/EC) [13], administrations have exempted many radio equipment from individual licensing, including satellite terminals. In addition, the CEPT Recommendation ERC/REC 01-07 [14], adopted in 1995 and revised in 2004, recommended the harmonised criteria for exempting radio equipment from individual licensing. One of the conditions identified in this Recommendation for exempting from individual licensing of radio equipment is (as stated by the Recommendation) “there is little risk of harmful interference being caused.”

The provision of Pan European services will be greatly assisted when all CEPT administrations exempt the same categories of radio equipment from individual licensing and facilitate their free circulation and use. The benefit of free circulation and use has been offered to mobile radio equipment operating to terrestrial and satellite systems. The ECC Decision ECC/DEC/(12)01 [15] on the exemption from individual licensing and free circulation and use of terrestrial and satellite mobile terminals, clarified the regulatory position “free circulation and use” as free circulation with permission to use the radio equipment. The Decision ECC/DEC/(12)01 applied to a limited number of satellite terminals and it did not apply to satellite terminals installed permanently on maritime vessels or aircraft.

While land based ESIM could be subject to exemption from individual licensing, it is however recognised that ESIM installed and used onboard vessels and aircrafts may have to be subject to some form of licensing depending upon national licensing regulations. It is known that some administrations license all radio equipment installed onboard a vessel and/or an aircraft, and provide licence documentation to be placed onboard the vessel and/or the aircraft.

ESIM working to NGSO satellite systems use the band 14.0-14.5 GHz for transmissions to satellites. The lower half of the band, namely the 14.0-14.25 GHz band, is available exclusively to satellite services. However, as discussed above, the upper half of the band, namely the 14.25-14.5 GHz band, is also allocated to the fixed service and the radio astronomy service, with deployment in a several CEPT countries. ESIM deployed with free circulation and use within the CEPT should have an inherent capability to operate without causing interference to FS and RAS.

7.1 OPERATION OF ESIM UNDER THE FIXED-SATELLITE SERVICE ALLOCATION

“Earth Stations in-Motion” is a concept that has been devised by the CEPT with the establishment of a regulatory framework for the Ka-band GSO “Earth Stations on Mobile Platforms” (ESOMP) in the year 2013 (see ECC Report 184 [16]). Later, the CEPT adopted a similar framework for NGSO ESOMP. The term ESOMP was originally used to describe such earth stations in-motion, and this term was later changed to ESIM at the WRC-15.

When considering the regulatory framework for Ka-band GSO ESOMP, the CEPT concluded that such deployment of ESOMP shall be under the FSS allocations at Ka-band. This conclusion was reached following the consideration of several factors, amongst other things, the operation of the ESOMP within the

GSO or the NGSO satellite system. Some of these factors also apply to operation of ESIM to NGSO FSS satellite systems at 14 GHz. These are listed below.

- NGSO satellite systems operate under the 11 GHz and 14 GHz FSS allocations given in the Radio Regulations [6]. Fixed earth stations and ESIM are deployed with these NGSO satellite systems. Fixed earth stations and ESIM have similar characteristics and comply with all relevant regulatory provisions of the Radio Regulations applying to NGSO satellite systems, including the compliance with EPFD limits to protect the GSO networks.
- Fixed earth stations and ESIM have to operate under the same frequency coordination agreements reached between NGSO satellite system (within which such fixed earth stations and ESIM operate) and other GSO networks and NGSO systems. This requires the operation of ESIM and its interference environment to be no different to those of the fixed earth stations. In other words, ESIM should behave exactly the same as fixed earth stations in relation to its interference environment.
- The interference scenarios for FS and RAS resulting from ESIM are no different to those resulting from fixed earth stations. This is because, as illustrated in Section 3 of this Report, the NGSO satellite system ensures that when a given ESIM enters a protection zone established for FS or RAS, it ceases transmissions in frequency bands overlapping the bands used by FS or RAS, and maintains that position while in the protection zone. A protection zone is a zone established for a given FS or RAS station within which ESIM working to a given NGSO satellite system has the potential to cause interference to the FS or the RAS station. A terrain database may be used when evaluation such protection zones.
- The following design considerations also assist the operation of an ESIM to emulate a FSS fixed earth station:
 - Mis-pointing of the earth station antenna. This could result from, amongst other things, motion induced antenna pointing errors, effects caused by bias and latency of their pointing systems, tracking error of open or closed loop tracking systems, misalignment between transmit and receive apertures for systems that use separate apertures, and misalignment between transmit and receive feeds for systems that use combined apertures. The design of ESIM incorporated all such considerations, enabling the ESIM to comply with the relevant technical specification on mis-pointing stipulated in the ETSI standard EN 303 980 [4];
 - Variations in the antenna pattern of the earth station antenna. Where applicable, this includes, at least, effects caused by manufacturing tolerances, ageing of the antenna and environmental effects. Networks using certain types of antennas, such as phased arrays, should account for variation in antenna pattern with scan angles (elevation and azimuth). Networks using phased arrays should also account for element phase error, amplitude error and failure rate;
 - Variations in the transmit e.i.r.p. from the earth station. Where applicable, this includes, at least, effects caused by measurement error, control error and latency for closed loop power control systems, and motion-induced antenna pointing errors.

Taking all of the above into account, the ECC concluded that ESIM are to be treated as FSS earth stations and therefore operate in bands 10.7-12.5 GHz and 14-14.25 GHz available for FSS earth stations. Accordingly, given that these frequency bands are generally identified for FSS satellite systems within the CEPT, the CEPT could also designate these bands for NGSO FSS satellite systems.

7.2 REGULATORY CONSIDERATIONS FOR DEPLOYMENT OF ESIM WITHIN THE 14.0-14.25 GHZ BAND

The band 14.0-14.25 GHz has already been designated to the fixed-satellite service under several ECC Decisions, and earth stations have been offered exemption from licensing, and transportable and mobile earth stations have been provided with free circulations, in some cases with some limited conditions on e.i.r.p. It therefore follows that ESIM working to NGSO satellite systems could also be operated under such regulatory framework, allowing for exemption from individual licensing, and provides for free circulation and use within the CEPT. ECC Report 271 noted that ESIM operate with low power, in some cases with 37 dBW. It is recognised that the implementation of such regulatory framework will be subject to national consideration by each of the CEPT administrations.

7.3 REGULATORY CONSIDERATIONS FOR DEPLOYMENT OF ESIM WITHIN THE 14.25-14.5 GHZ BAND

Section 3 of this Report identified other services deployed within the CEPT in the 14.25-14.5 GHz band as fixed and radio astronomy, deployed within about five and six administrations, respectively. The use of this band for NGSO ESIM in these administrations therefore requires further regulatory consideration.

7.3.1 ESIM compatibility with the fixed and radio astronomy services

Section 4 of this Report, when addressing compatibility issues, described the technical measures necessary for maintaining the required compatibility between ESIM and fixed and radio astronomy services. This section of the Report addresses the regulatory conditions that would be necessary for the ESIM to comply with such technical measures.

Table 4 lists the regulatory conditions that may be placed on ESIM deployments in order to ensure that compatibility between ESIM and fixed and radio astronomy services is maintained.

Table 4: Regulatory conditions for maintaining compatibility with fixed and radio astronomy services

ESIM operation	Fixed service: Regulatory conditions for compatibility	Radio astronomy service: Regulatory conditions for compatibility
Land	<p>A protection zone for each fixed link to be determined on a case by case basis using the methodology given in the ECC Report 271 [1], and in consultation with and agreement of the administration concerned.</p> <p>The NGSO satellite system by deploying the control of emission function, stipulated in the ETSI standard EN 303 980 [4] (see Section 2.2 above) shall ensure a land ESIM ceases transmissions in the frequency bands overlapping the frequency band used by a given fixed link when located within its protection zone. Such cessation of transmissions in the relevant frequency band within the protection zone would ensure compatibility between the land ESIM and the fixed link.</p> <p>The regulatory condition will require the satellite system operator to establish protection zones with a case by case analysis of FS deployments using the methodology given in the ECC Report 271. The requirement to protect FS in neighbouring administrations should also be considered. The compliance with such a regulatory condition will ensure protection of fixed link receivers from any interference from the land ESIM transmissions, and would allow the administrations to authorise land ESIM operation in the band 14-14.5 GHz under licence-exemption and free circulation and use.</p>	<p>A protection zone for each radio astronomy station to be determined on a case by case basis using the methodology given in the ECC Report 271 [1], and in consultation with and agreement of the administration concerned.</p> <p>The NGSO satellite system by deploying the control of emission function, stipulated in the ETSI standard EN 303 980 [4] (see Section 2.2 above) shall ensure a land ESIM ceases transmissions in the band 14.47-14.5 GHz when located within the protection zone of a given RAS station. Such cessation of transmissions in the 14.47-14.5 GHz band within the protection zone would ensure compatibility between the land ESIM and the RAS station.</p> <p>The regulatory condition will require the satellite system operator to establish protection zones with a case by case analysis of RAS stations using the methodology given in the ECC Report 271. The requirement to protect RAS stations of neighbouring administrations should also be considered. The compliance with such regulatory condition will ensure protection of radio astronomy observations from any interference from the land ESIM transmissions, and would allow the administrations to authorise land ESIM operation in the band 14-14.5 GHz under licence-exemption and free circulation and use.</p>

ESIM operation	Fixed service: Regulatory conditions for compatibility	Radio astronomy service: Regulatory conditions for compatibility
Maritime	<p>A protection zone for each fixed link to be determined on a case by case basis using the methodology given in ECC Report 271 [1], and in consultation with and agreement of the administration concerned.</p> <p>In the case of land ESIM working to OneWeb NGSO satellite system, no separation distance is required to maintain compatibility with fixed links in the band 14.25-14.5 GHz.</p> <p>The NGSO satellite system by deploying the control of emission function, stipulated in the ETSI standard EN 303 980 [4] (see Section 2.2 above) shall ensure maritime ESIM ceases transmissions in the frequency bands overlapping the frequency band used by a given fixed link when located within its protection zone. Such cessation of transmissions in relevant frequency bands would ensure compatibility between the maritime ESIM and the fixed link.</p> <p>The regulatory condition will require the satellite system operator to establish protection zones with a case by case analysis of FS deployments as specified in the ECC Report 271, i.e. using the methodology given the Recommendation ITU-R SF.1650 [8].</p> <p>In the case of OneWeb it has already been established in ECC Report 271 such a separation distance is not required. The requirement to protect FS in neighbouring administrations should also be considered. The compliance with such a regulatory condition will ensure protection of fixed link receivers from any interference from maritime ESIM transmissions, and this would allow the administrations to authorise maritime ESIM operation in the band 14-14.5 GHz under an appropriate licensing framework.</p>	<p>A protection zone for each radio astronomy station to be determined on a case by case basis using the methodology given in the ECC Report 271 [1], and in consultation with and agreement of the administration concerned.</p> <p>The NGSO satellite system by deploying the control of emission function, stipulated in the ETSI standard EN 303 980 [4] (see Section 2.2 above) shall ensure maritime ESIM ceases transmissions in the band 14.47-14.5 GHz when located within the protection zone of a given RAS station. Such cessation of transmissions in the 14.47-14.5 GHz band would ensure compatibility between maritime ESIM and the RAS station.</p> <p>The regulatory condition will require the satellite system operator to establish protection zones with a case analysis of RAS stations. The requirement to protect RAS stations of neighbouring administrations should also be considered. The compliance with such regulatory condition will ensure protection of radio astronomy observations from any interference from maritime ESIM transmissions, and would allow the administrations to authorise maritime ESIM operation in the band 14-14.5 GHz under an appropriate licensing framework.</p>
Aeronautical	<p>A PFD mask on Earth (within the 14.25-14.5 GHz) to be derived using the NGSO system and airborne ESIM characteristics that provides for the protection of Fixed links.</p> <p>A PFD mask (on Earth) has been derived to protect FS from an airborne ESIM operating OneWeb satellite system, using the characteristics of the OneWeb system. This PFD mask is given in Table 2 in Section 3.1 above. This mask will be applicable to all</p>	<p>Airborne ESIM working to any NGSO satellite system will be required to cease transmissions in the 14.47-14.5 GHz when in visibility of a RAS station performing observations in this band.</p> <p>The regulatory condition will require the satellite system to have the control of emission function and cease transmissions in the band 14.47-14.5 GHz from airborne ESIM when the airborne ESIM is in visibility</p>

ESIM operation	Fixed service: Regulatory conditions for compatibility	Radio astronomy service: Regulatory conditions for compatibility
	<p>NGSO satellite system using TDMA access method.</p> <p>The compliance with the PFD mask on Earth will ensure protection of fixed link receivers from any interference from airborne ESIM transmissions. This would allow the administrations to authorise airborne ESIM operation in the band 14-14.5 GHz under an appropriate licensing framework.</p>	<p>of a RAS station. The location of RAS stations within the CEPT (and elsewhere) will be established in liaison with CRAF.</p> <p>The compliance with such regulatory condition will ensure protection of radio astronomy observations from any interference from airborne ESIM transmissions and would allow the administrations to authorise airborne ESIM operation in the band 14-14.5 GHz under an appropriate licensing framework.</p>

7.3.2 Protection of aircraft in the vicinity of airfields

ECC Report 272 [17] assessed the protection of aircraft from ESIM deployed in the vicinity of airfields. It stated that there would be no additional constraint imposed on land, maritime or airborne ESIM operating with e.i.r.p. lower than 54.5 dBW in the Ku-band. The e.i.r.p of NGSO earth stations documented in the ECC Report 271 is 34 dBW for the OneWeb system, 20 dB below the e.i.r.p limit. Therefore there should be no restriction regarding High Intensity Radiated Field (HIRF) aircraft protection on the operation of land, maritime or airborne ESIM, operating with e.i.r.p up to 54.5 dBW, within or in the vicinity of airfields.

An explicit e.i.r.p of 54.5 dBW has to be included in the ECC Decision for NGSO ESIM.

8 LICENSING AND FREE CIRCULATION AND USE CONSIDERATION

Every administration requires all transmitting radio stations to be licensed under its national regulations. Administrations also exempt specific transmitting stations from requiring individual licences when such transmitting stations comply with technical and regulatory conditions set by the administration. Administrations also allow free circulation and use (i.e. transmitting radio stations that may have been exempted from individual licensing in another administration, to be brought into the country and operated) when such free circulation and use is authorised by its national regulations.

Section 6 of this Report on regulatory framework stated that exemption from individual licensing should be considered when the risk of harmful interference is negligible. Over the years, the CEPT administrations have generally adopted this position. ECC Report 132 [17] published in June 2009, based on the survey of licensing frameworks in the CEPT administrations, offered a framework for licensing as shown in Table 5.

Table 5: Key characteristics of different licensing regimes [17]

Individual authorisation (Individual rights of use)		General authorisation (No individual rights of use)	
Individual licence (Note 1)	Light-licensing		Licence-exemption
Individual frequency planning / coordination. Traditional procedure for issuing licences.	Individual frequency planning / coordination. Simplified procedure compared to traditional procedure for issuing licences. With limitations in the number of users.	No individual frequency planning / coordination. Registration and/or notification. No limitations in the number of users nor need for coordination.	No individual frequency planning / coordination. No registration or notification.

Note 1: Sometimes also referred to as "traditional licensing"

The approach taken by the CEPT for licensing earth stations is consistent with the Authorisation Directive [11], the CEPT Recommendation ERC/REC 01-07 [14], and the regulatory framework identified in the ECC Report 132 [17]. The CEPT in 1990s took the approach to allow exemption from individual licensing, and allow free circulation and use when certain earth stations had minimal potential to cause interference to other services. An early example of such CEPT regulations is the ERC Decision ERC/DEC/(95)01 [19] where certain Inmarsat and Eutelsat terminals were offered free circulation and use within the CEPT.

In recent years, following the general authorisation principle, CEPT provided for free circulation and use, and exemption from individual licensing also based on spectrum management consideration. Examples of recent CEPT regulations are the ECC/DEC/(13)01 [2] on Ka-band GSO ESOMP and ECC/DEC/(15)04 [3] on Ka-band NGSO ESOMP.

The same regulatory principle or the framework could be extended to the authorisation of ESIM operating to 11 and 14 GHz NGSO satellite systems. The following sections describe such a regulatory framework in detail.

8.1 CONSIDERATION OF NGSO ESIM OPERATION IN THE 14-14.5 GHZ BAND

Section 2 above noted 14-14.25 GHz band is available for exclusive use of FSS, and therefore the use of the band by NSGO ESIM (land, maritime and aeronautical) poses no interference risk to any other authorised service. Following the principles identified above the NGSO ESIM could be offered exemption from individual licences and allowed free circulation and use within this band and throughout the CEPT.

CEPT studies showed that only a few administrations deploy FS and/or RAS within the 14.25-14.5 GHz band, and these deployments of FS and RAS should be protected from ESIM transmissions. This Report described the interference avoidance mechanisms that may be deployed by the NGSO satellite system enabling ESIM to operate (depending on the land, maritime or aeronautical use) without causing interference to FS or RAS. This should also enable ESIM to be considered for exemption from individual licensing and free circulation and use even in the presence of FS and RAS deployments in the 14.25-14.5 GHz band.

The administrations neighbouring those that deploy FS and/or RAS within the band 14.25-14.5 GHz should also consider the interference avoidance mechanisms discussed when authorising ESOM.

It should be noted that some administrations issue individual licences to shipborne and/or airborne ESIM in order to comply with their national regulations.

8.2 CONSIDERATION OF THE NGSO FSS DOWNLINK IN THE 10.7-12.5 GHZ BAND

The CEPT has identified the potential interference from adjacent band emissions from NGSO satellite downlinks in the 10.7-12.5 GHz into RAS and EESS in the band 10.6-10.7 GHz. This Report established that such assessments should be made for each NGSO satellite system operating in the band 10.7-12.5 GHz taking into account the specific system characteristics of NGSO satellite system. Following the assessments made, the CEPT established that out of band emissions of the downlink in the 10.7-12.5 GHz of OneWeb NGSO satellite system would comply with the protection requirements of RAS and EESS (passive) with the application of interference mitigation methods limiting unwanted emissions in the 10.6-10.7 GHz band discussed in sections 4 and 5. The CEPT has taken the view that the interference potential of other NGSO satellite systems operating it downlink in the band 10.7-12.5 GHz should be assessed on a case by case basis to determine their potential to cause interference to RAS and EESS (passive).

8.3 SUMMARY ON LICENSING AND FREE CIRCULATION AND USE

The positions described above can be summarised as follows:

Table 6: Summary on licensing and free circulation and use

ESIM Frequency band (Status of allocation)	Regulatory condition	Authorisation
14-14.25 GHz 14.25-14.5 GHz (Exclusive FSS allocation)	Land, shipborne and airborne ESIM: No potential interference to other authorised services. No regulatory conditions	Licence-exemption and free circulation and use It should be noted that some administrations issue individual licences to shipborne and/or airborne ESIM in order to comply with national regulations.
14.25-14.5 GHz (Co-primary allocation to FSS and FS, secondary allocation to RAS.)	Land, and shipborne ESIM: Regulatory condition: Protection zones to be agreed with each administration deploying FS and/or RAS. NGSO satellite system will ensure cessation of transmissions from ESIM in frequency bands overlapping those assigned to FS within the protection zone	Administrations with FS and/or RAS deployment: Licence-exemption and free circulation and use for both land and shipborne ESIM when complying with the regulatory condition. Also take into account any need to protect FS and/or RAS in neighbouring administrations. It should be noted that some administrations issue individual licences to shipborne ESIM in order to comply with national regulations.

ESIM Frequency band (Status of allocation)	Regulatory condition	Authorisation
14.25-14.5 GHz (co-primary allocation to FSS and FS)	Airborne ESIM: Regulatory condition: Protection of FS to be assured with the compliance with the PFD mask on Earth resulting from airborne ESIM.	Administrations with FS deployment: Licence-exemption and free circulation and use for airborne ESIM when complying with the regulatory condition. Also take into account any need to protect FS in neighbouring administrations. It should be noted that some administrations issue individual licences to airborne ESIM in order to comply with national regulations.
14.47-14.5 GHz (primary allocation to FSS and secondary allocation to RAS)	Airborne ESIM: Regulatory condition: Protection of RAS to be assured with the cessation of transmission when airborne ESIM is visible to the RAS station.	Administrations with RAS deployment: Licence-exemption and free circulation and use for airborne ESIM when complying with the regulatory condition. Also take into account any need to protect RAS in neighbouring administrations. It should be noted that some administrations issue individual licences to airborne ESIM in order to comply with national regulations.

9 CONCLUSIONS

This Report confirmed that ESIM are to be treated as FSS earth stations and therefore operate in bands 10.7-12.5 GHz and 14-14.25 GHz available for FSS earth stations.

This Report examined the regulatory basis for authorising ESIM (land, shipborne and airborne) in the 14-14.5 GHz band. It found that the 14-14.5 GHz band is available for exclusive use by the FSS in most CEPT administrations, therefore ESIM may be authorised by those administrations on the basis of exemption from individual licensing, and allowed free circulation and use.

This Report set the maximum e.i.r.p value that ensures HIRF aircraft protection for such earth stations as 54.5 dBW.

This Report also found that in a limited number of CEPT administrations fixed links of the fixed service are operated, and observations within the radio astronomy service are made in the 14.25-14.5 GHz band and 14.47-14.5 GHz band, respectively. In such cases the Report found that the technical measures to be deployed by the NGSO FSS satellite system and its ESIM, as reported in ECC Report 271 [1], provide necessary protection for FS and RAS stations. The Report established that these administrations with FS and RAS deployments (or having such deployments in their neighbouring administrations) could also authorise ESIM to operate in the 14-14.5 GHz band with exemption from individual licensing and free circulation and use.

This Report established that some administration may authorise shipborne and/or airborne ESIM under individual licensing in order to comply with national regulations.

This Report also established that the management of interference to the RAS and EESS (passive) in the 10.6-10.7 GHz band is achieved by satellite system-specific measures, limiting unwanted emissions in the band 10.6-10.7 GHz, including suppression of satellite transmissions in the channel immediately adjacent to 10.7 GHz in vicinity of RAS and EESS (passive) stations. Since compatibility studies within ECC Report 271 were limited to single NGSO satellite system, the potential of any other NGSO satellite system operating its downlink in the band 10.7-12.5 GHz to cause interference to RAS and EESS (passive) in the band 10.6-10.7 GHz should be assessed on a case by case basis, taking into account the aggregate effect of the NGSO and GSO systems.

ANNEX 1: LIST OF REFERENCE

- [1] ECC Report 271 - "Compatibility and sharing studies related to NGSO satellite systems operating in the FSS bands 10.7-12.75 GHz (space-to-Earth) and 14-14.5 GHz (Earth-to-space)"
- [2] ECC Decision (13)01 - "The use, free circulation, and exemption from individual licensing of Earth stations on mobile platforms (ESOMPs) in the frequency bands available for use by uncoordinated FSS Earth stations within the ranges 17.3-20.2 GHz and 27.5-30.0 GHz"
- [3] ECC Decision (15)04 - "The harmonised use, free circulation and exemption from individual licensing of Land and Maritime Earth Stations On Mobile Platforms (ESOMPs) operating with NGSO FSS satellite systems in the frequency ranges 17.3-20.2 GHz, 27.5-29.1 GHz and 29.5-30.0 GHz"
- [4] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC
- [5] ETSI EN 303 980 V1.1.1 - "Satellite Earth Stations and Systems (SES); Harmonised Standard for fixed and in-motion Earth Stations communicating with non-geostationary satellite systems (NEST) in the 11 GHz to 14 GHz frequency bands covering essential requirements of article 3.2 of Directive 2014/53/EU"
- [6] ITU Radio Regulations, Edition of 2016
- [7] ERC Recommendation 13-03 - "The use of the band 14.0 - 14.5 GHz for Very Small Aperture Terminals (VSAT) and Satellite News Gathering (SNG)", December 1996
- [8] Recommendation ITU-R SF.1650-1 - "The minimum distance from the baseline beyond which in-motion earth stations located onboard vessels would not cause unacceptable interference to the terrestrial service in the bands 5 925-6 425 MHz and 14-14.5 GHz"
- [9] Recommendation ITU-R RA.769-2 - "Protection criteria used for radio astronomical measurements"
- [10] Recommendation ITU-R RS.1861-0 - "Typical technical and operational characteristics of earth exploration-satellite service (passive) systems using allocations between 1.4 and 275 GHz"
- [11] Recommendation ITU-R RS.2017-0 - "Performance and interference criteria for satellite passive remote sensing"
- [12] Directive 2002/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services (Authorisation Directive)
- [13] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity
- [14] ERC Recommendation 01-07 - "Harmonised regime for exemption from individual licensing for the use of radio spectrum"
- [15] ECC Decision (12)01 - "Exemption from individual licensing and free circulation and use of terrestrial and satellite mobile terminals"
- [16] ECC Report 184 - "The Use of Earth Stations on Mobile Platforms Operating with GSO Satellite Networks in the Frequency Range 17.3-20.2 GHz and 27.5-30.0 GHz"
- [17] ECC Report 272 - "Earth Stations operating in the frequency bands 4-8 GHz, 12-18 GHz and 18-40 GHz in the vicinity of aircraft"
- [18] ECC Report 132 - "Light Licensing, Licence-Exempt and Commons"
- [19] ERC Decision (95)01 - "The free circulation and use of certain radio equipment in CEPT member countries"