ETSI TR 103 399 V1.1.1 (2019-04)

System Reference document (SRdoc);
Fixed and in-motion Earth stations communicating with satellites in non-geostationary orbits in the 11 GHz to 14 GHz frequency band

Reference
DTR/ERM-532

Keywords
broadband, satellite, SRdoc

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights 4
Foreword 4
Modal verbs terminology 4
Executive summary 4
Introduction 5
1 Scope 6
2 References 6
2.1 Normative references 6
2.2 Informative references 6
3 Definition of terms, symbols and abbreviations 8
3.1 Terms 8
3.2 Symbols 8
3.3 Abbreviations 8
4 Comments on the System Reference Document 9
5 Presentation of the system 9
6 Market information 10
7 Technical information 12
7.0 General 12
7.1 Detailed technical description 12
7.2 Technical parameters and implications on spectrum 13
7.2.0 General 13
7.2.1 Status of technical parameters 14
7.2.1.1 Current ITU and European Common Allocations 14
7.2.1.2 Sharing and compatibility studies 14
7.2.2 Transmitter parameters 17
7.2.2.0 General 17
7.2.2.1 Transmitter Output Power/Radiated Power 18
7.2.2.2 Operating Frequency 18
7.2.2.3 Bandwidth 18
7.2.2.4 Spurious emissions 18
7.2.3 Receiver parameters 18
7.2.4 Channel access parameters 19
7.2.5 User terminal parameters required for compatibility assessments 20
7.3 Information on relevant standard(s) 22
8 Radio spectrum request and justification 22
9 Regulations 23
9.1 Current regulations 23
9.2 Proposed regulation and justification 25
History 27

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Executive summary

Satellite systems in non-geostationary orbits in the 11 GHz to 14 GHz frequency band and in Low Earth Orbit (LEO) plan to provide high-quality, broadband Internet access to small low-cost user terminals located anywhere on the Earth. The user terminals will be either a fixed Earth station, or Earth Stations In Motion (ESIMs), which have similar characteristics as existing terminals operating to geostationary satellite systems.

The service provided by these LEO constellations will be comparable in quality to the terrestrial broadband services available in densely populated areas of developed countries today (i.e. high data volume, high data rates/speed and low latency). In addition, because the LEO satellites operate at a much lower altitude (e.g. 800 km to 1 400 km) than GSO satellites (i.e. 36 000 km), users on LEO satellite systems will experience round trip delay for the space related path of less than 30 milliseconds, which is about 16 times to 17 times lower than that of geostationary satellites (480 ms to 530 ms). The latency offered by LEO systems is comparable with terrestrial technologies. Non geostationary satellite systems deployed in low Earth orbits can also offer very large throughput, thereby bringing very high speed connectivity to the users consistent with the terrestrial high speed broadband services.

The satellite applications to fixed Earth stations and ESIMs of non-geostationary systems operate within the Fixed Satellite Service (FSS) at frequency bands 10,7 GHz to 12,75 GHz (space to Earth), 12,75 GHz to 13,25 GHz and 14,0 GHz to 14,5 GHz (Earth to space). Both fixed Earth stations and ESIMs operate with low EIRP (aggregate EIRP of less than 40 dBW per carrier) and use antennas that track continuously the satellites in non-geostationary orbits.

Introduction

The present document has been developed as a contribution to the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT).

It is intended to describe the system requirements based on the technology developed for a non-geostationary satellite system, polar orbiting constellation, in the 11 GHz to 14 GHz frequency bands that provides broadband services to fixed and in-motion Earth stations. The requirements provide a basis for industry to quickly implement an innovative and efficient system within Europe, as a part of a global system, while avoiding harmful interference with other services and systems.

1 Scope

The present document describes a system designed to provide broadband communication to fixed and in-motion Earth stations from a NGSO satellite system operating in the 11 GHz to 14 GHz frequency band. The present document may be used as a reference to a regulatory framework being developed by the CEPT in connection with such NGSO satellite systems, thus providing additional information to support the framework for free circulation and exemption from individual licensing of fixed or in motions earth stations.

These satellite systems will allow the deployment of cost effective and spectrum efficient solutions that will offer the possibility of extending affordable broadband services to all parts of the world, particularly the rural and remote areas, where high speed broadband services are not readily available, thus addressing the digital divide of many nations.

The present document also includes, in particular:

- Market information.
- Technical information.
- Regulatory matters.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] CEPT European Common Allocation Table (ECA Table) in ERC Report 25.

[i.2] ETSI EN 301 428: "Satellite Earth Stations and Systems (SES); Harmonised Standard for Very Small Aperture Terminal (VSAT); Transmit-only, transmit/receive or receive-only satellite earth stations operating in the 11/12/14 GHz frequency bands covering the essential requirements of article 3.2 of Directive 2014/53/EU".

[i.3] ECC Report 66: "Protection of aircraft from satellite earth stations operating on the ground in the vicinity of airfields".

[i.4] ETSI EN 303 980: "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".

[i.5] ETSI EN 302 186: "Satellite Earth Stations and Systems (SES); Harmonised Standard for satellite mobile Aircraft Earth Stations (AESs) operating in the 11/12/14 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.6] ETSI EN 301 459: "Satellite Earth Stations and Systems (SES); Harmonised Standard for Satellite Interactive Terminals (SIT) and Satellite User Terminals (SUT) transmitting towards satellites in geostationary orbit, operating in the 29,5 GHz to 30,0 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.7] ETSI EN 301 360: "Satellite Earth Stations and Systems (SES); Harmonised Standard for Satellite Interactive Terminals (SIT) and Satellite User Terminals (SUT) transmitting towards satellites in geostationary orbit, operating in the 27,5 GHz to 29,5 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.8] ETSI EN 301 430: "Satellite Earth Stations and Systems (SES); Harmonised Standard for Satellite News Gathering Transportable Earth Stations (SNG TES) operating in the 11 GHz to 12 GHz/ 13 GHz to 14 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.9] ETSI EN 302 340: "Satellite Earth Stations and Systems (SES); Harmonised Standard for satellite Earth Stations on board Vessels (ESVs) operating in the 11/12/14 GHz frequency bands allocated to the Fixed Satellite Service (FSS) covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.10] ETSI EN 302 977: "Satellite Earth Stations and Systems (SES); Harmonised Standard for Vehicle-Mounted Earth Stations (VMES) operating in the 14/12 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.11] ETSI EN 301 427: "Satellite Earth Stations and Systems (SES); Harmonised Standard for low data rate Mobile satellite Earth Stations (MES) except aeronautical mobile satellite earth stations, operating in the 11/12/14 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.12] ETSI EN 302 448: "Satellite Earth Stations and Systems (SES); Harmonised Standard for tracking Earth Stations on Trains (ESTs) operating in the 14/12 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.13] ECC/DEC/(06)02: "Decision of 24 March 2006 on Exemption from Individual Licensing of low e.i.r.p. satellite terminals (LEST) operating within the frequency bands 10.70 - 12.75 GHz or 19.70 - 20.20 GHz Space-to-Earth and 14.00 - 14.25 GHz or 29.50 - 30.00 GHz Earth-to-Space".

[i.14] ECC/DEC/(06)03: "Decision of 24 March 2006 on Exemption from Individual Licensing of high e.i.r.p. satellite terminals (HEST) operating within the frequency bands 10.70 - 12.75 GHz or 19.70 - 20.20 GHz space-to-Earth and 14.00 -14.25 GHz or 29.50 - 30.00 GHz Earth-to-space".

[i.15] ECC/DEC/(05)10: "ECC Decision of 24 June 2005 on the free circulation and use of Earth Stations on board Vessels operating in fixed satellite service networks in the frequency bands 14-14.5 GHz (Earth-to-space), 10.7-11.7 GHz (space-to-Earth) and 12.5-12.75 GHz (space-to-Earth)".

[i.16] ECC/DEC/(05)11: "The free circulation and use of Aircraft Earth Stations (AES) in the frequency bands 14.0-14.5 GHz (Earth-to-space), 10.7-11.7 GHz (space-to-Earth) and 12.5-12.75 GHz (space-to-Earth)".

[i.17] ECC/DEC/(13)01: "The harmonised use, free circulation and exemption from individual licensing of Earth Stations On Mobile Platforms (ESOMPs) with in the frequency bands 17.3-20.2 GHz and 27.5-30.0 GHz".

[i.18] ECC/DEC/(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".

[i.19] ECC/DEC/(17)04: "The harmonised use and exemption from individual licensing of fixed earth stations operating with NGSO FSS satellite systems in the frequency bands 10.7-12.75 GHz and 14.0-14.5 GHz".

[i.20] ITU Radio Regulations.

[i.21] Recommendation ITU-R RA.769-2: "Protection criteria used for radio astronomical measurements".

[i.22] 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.

[i.23] REVISED ERC/REC 01-07 (Bonn 1995, Helsinki 2000, Mainz 2004): "Harmonised regime for exemption from individual licensing for the use of radio spectrum".

[i.24] 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.

[i.25] CEPT/ERC REC 13-03 E: (The Hague 1996): "The use of the band 14.0-14.5 ghz for very small aperture terminals (vsat) and satellite news gathering (SNG)".

[i.26] SE19(16)75 Annex 2rev1: "Sharing between non-GSO FSS earth stations and fixed service in the band 14.25-14.5 GHz".

[i.27] CEPT 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)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3G	3rd Generation
ABW	Allocated Bandwidth
ACP	Adjacent Channel Power
AES	Aircraft Earth Station
CEPT	European Conference of Postal and Telecommunications administrations
ECC	Electronic Communications Committee
EESS	Earth Exploration Satellite Service
EIRP	Equivalent Isotropically Radiated Power
EMC	Electromagnetic Compatibility
EN	European Norm
EPFD	Equivalent Power Flux Density
ERC	European Radiocommunications Committee
ESIM	Earth Stations In-Motion
ESIMs	Earth Stations In Motion
ESV	Earth Stations on Vessels
EU	European Union
FS	Fixed Service
FSS	Fixed Satellite Service
GSO	Geostationary Satellite Orbit
HEST	High EIRP Satellite Terminals
ISP	Internet Service Provider
ITU-R	International Telecommunication Union - Radiocommunications sector

LEO	Low Earth Orbit
LEST	Low EIRP Satellite Terminals
LNB	Low Noise Block
LTE	Long-Term-Evolution
MNO	Mobile Network Operator
MSS	Mobile Satellite Service
NCC	Network Control Centre
NCF	Network Control Function
NEST	Fixed and in-motion Earth Stations Communicating with Non-Geostationary Satellite Systems
NGSO	Non-Geostationary Satellite Orbit
OBW	Occupied Bandwidth
PC	Power Control
PFD	Power Flux Density
PPDR	Public Protection and Disaster Relief
RAS	Radio Astronomy Service
RR	Radio Regulations
SIT	Satellite Interactive Terminal
SNG	Satellite News Gathering
SUT	Satellite User Terminal
TES	Transportable Earth Stations
TM	Transmission Mask
TR	Technical Report
UK	United Kingdom
UT	User Terminal
VMES	Vehicle-Mounted Earth Stations
VSAT	Very Small Aperture Terminal
WGSE	Working Group Spectrum Engineering (of ECC)

4 Comments on the System Reference Document

Void.

5 Presentation of the system

The satellite system presented in the present document makes use of non-geostationary low earth near polar orbits.. It offers the possibility of extending affordable broadband services to all parts of the world, particularly the rural and remote areas in order to bridge the digital divide. These systems also offer the possibility of extending cellular services by interfacing user devices through pico/fempto cell types (LTE, 3G and WiFi) within a limited local area, while deploying the satellite link as cellular backhaul infrastructure.

NGSO systems deployed in LEO offer the additional advantage of low latency, high volume and high data rates thereby bringing high speed connectivity to users, consistent with terrestrial high speed broadband services. The LEO NGSO systems offer the possibility of worldwide deployment of services as polar orbiting NGSOs reach all corners of the globe.

The satellite user terminals to be deployed with LEO NGSO systems include:

- fixed Earth station installations;
- ESIM installed on vehicles (including trains), ships and aircraft.

Fixed Earth stations will be low cost terminals and manufactured to facilitate a simple deployment. These user terminals will be particularly suitable for extending cellular services over a cellular backhaul infrastructure. These user terminals are designed for high volume, large scale deployments; they will be light-weight allowing for ease of deployment. Such a terminal will only weigh a few kilograms and can be connected to a power source or could be powered with built in solar panels. The terminals may employ either:

i) parabolic steerable antennas; or

ii) flat-plate phased array antennas.

ESIM are terminals mounted on vehicles, ships and aircraft, which use similar technology to fixed user terminals.

NGSO ESIM can also be custom made for specific applications, such as Public Protection and Disaster Relief (PPDR), Oil and Gas industry, and land, air and maritime transport.

6 Market information

LEO NGSO systems will provide high-speed, affordable broadband connectivity to anyone, anywhere. Building and sharing culture through communication is an essential and defining aspect of humanity.

Innovative non-geostationary satellite constellation will make available broadband access to many individuals who have limited or no service today, including people in rural and remote areas in both developed and developing countries.

When fully deployed, these NGSO constellations will support a wide variety of critical applications across the entire globe. To illustrate just a few:

- Community and Residential Internet Connectivity.
- Cellular Backhaul.
- Mobility Services.
- Emergency Communications.

LEO NGSO systems will extend the networks of mobile operators and Internet Service Providers (ISPs) to serve new areas, bringing voice and data access to consumers, businesses, schools, and other community locations that cannot technically or economically be served through terrestrial means.

The LEO NGSO systems' satellite terminal functions either as part of a cellular backhaul infrastructure to connect bases stations to MNO's networks (see figure 1), or as a small fempto/pico cell with, for example, LTE, 3G, WiFi connectivity (see figure 1) that can extend the networks of mobile operators by acting as a low-cost base station to which mobile users can connect.

LEO NGSO constellations will enable mobile operators' customers to access high speed (up to 50 Mbps downlink; and in some cases, even up to 250 Mbps) and low latency (less than 50 ms) benefits of those networks' infrastructure in areas such as "not spots" where mobile services are either not deployed or the quality of service is very low. Through roaming agreements, other operators' customers can also access the LEO NGSO network's infrastructure.

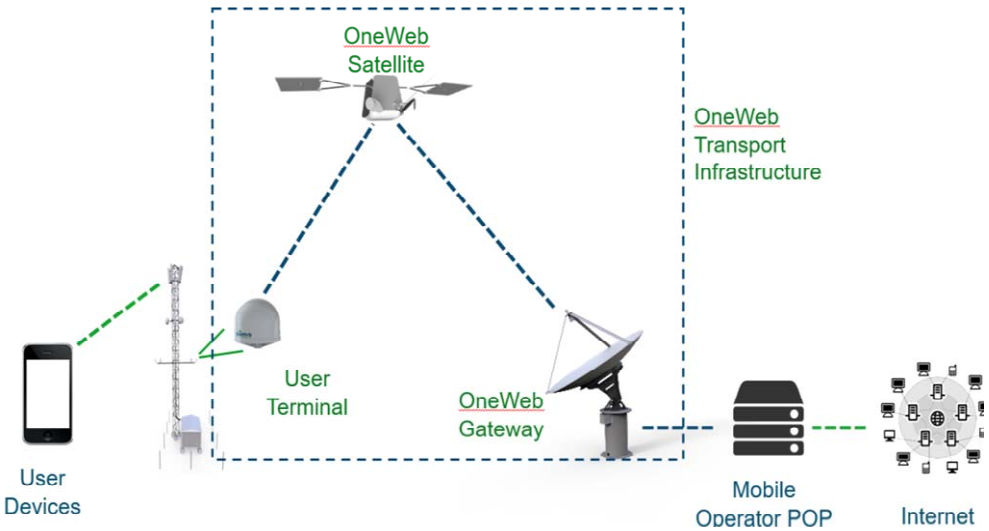


Figure 1: Basic Wholesale Cellular Backhaul Model

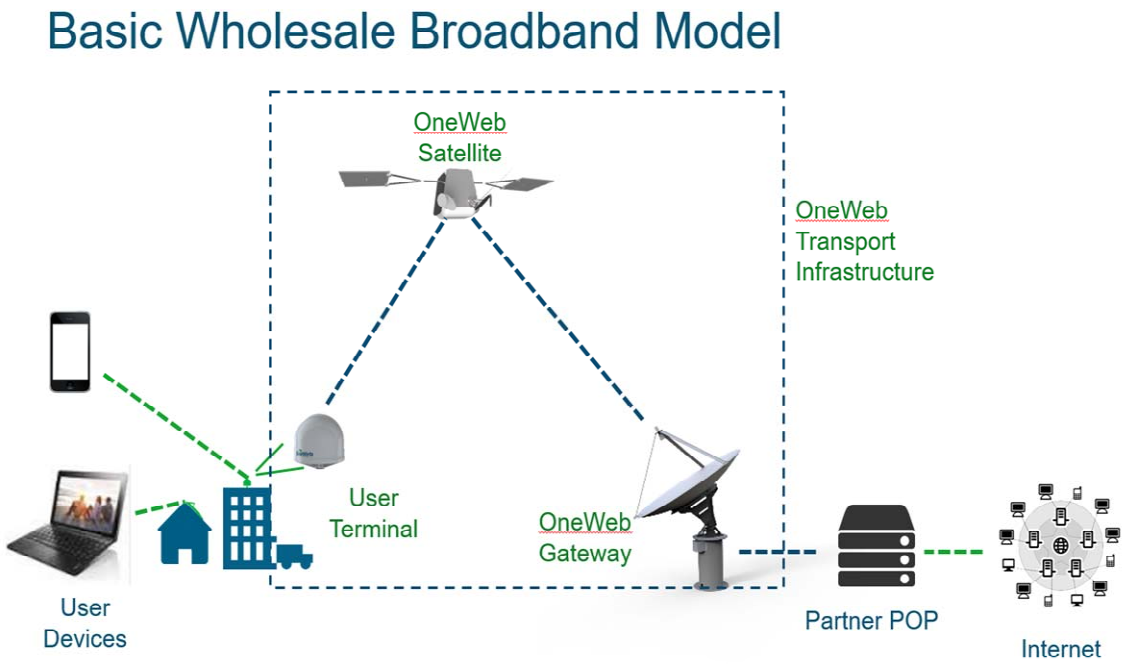


Figure 2: Basic Wholesale Broadband Model

LEO NGSO systems will also provide maritime and aeronautical applications (using a small cell to provide WiFi/LTE/3G connectivity to end-users) (see figure 3).

These NGSO systems will have several distinctive capabilities:

- Broadband speeds of over 50 Mbps downlink.
- Low latencies for the entire paths, approximately 50 ms.
- For maritime: coverage also within Polar circles and northwest passage.
- For aeronautical: global service from pole to pole for every aircraft from a single operator.

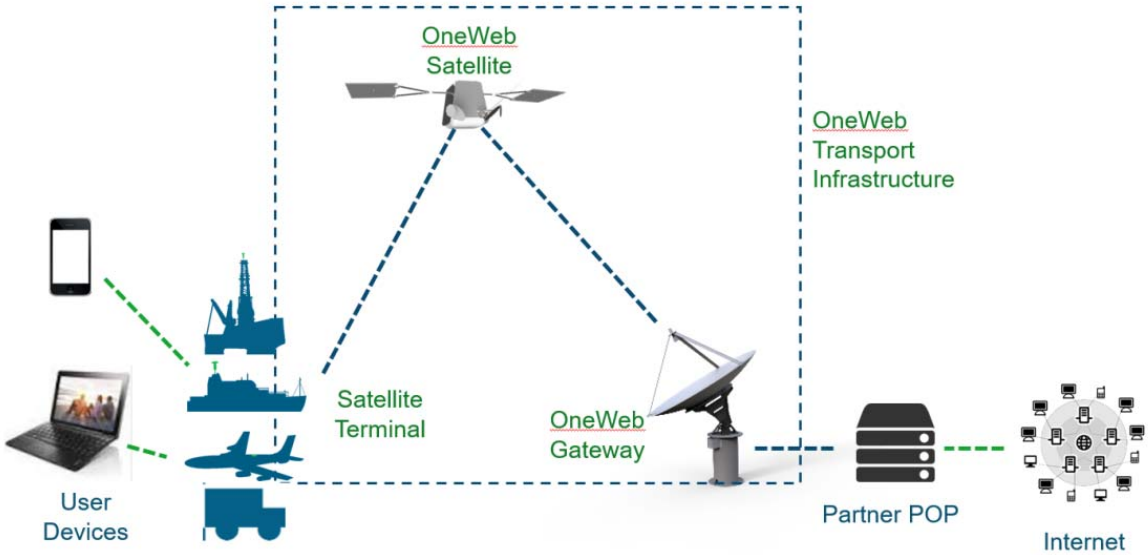


Figure 3: Basic Mobility Model

These LEO NGSO systems are also designed to support the work of the public protection and disaster relief (PPDR) emergency services during the most demanding crises, including those that strike unexpectedly, leaving communities suddenly without any terrestrial communications infrastructure. LEO NGSO systems carry the capability to offer PPDR applications in such situations. For example, a land-ESIM mounted on first responder's vehicle (see figure 4) will provide 4G quality Internet and voice directly to emergency vehicles to ensure connectivity for first responders, humanitarian workers, and medical personnel globally where and when it is needed.

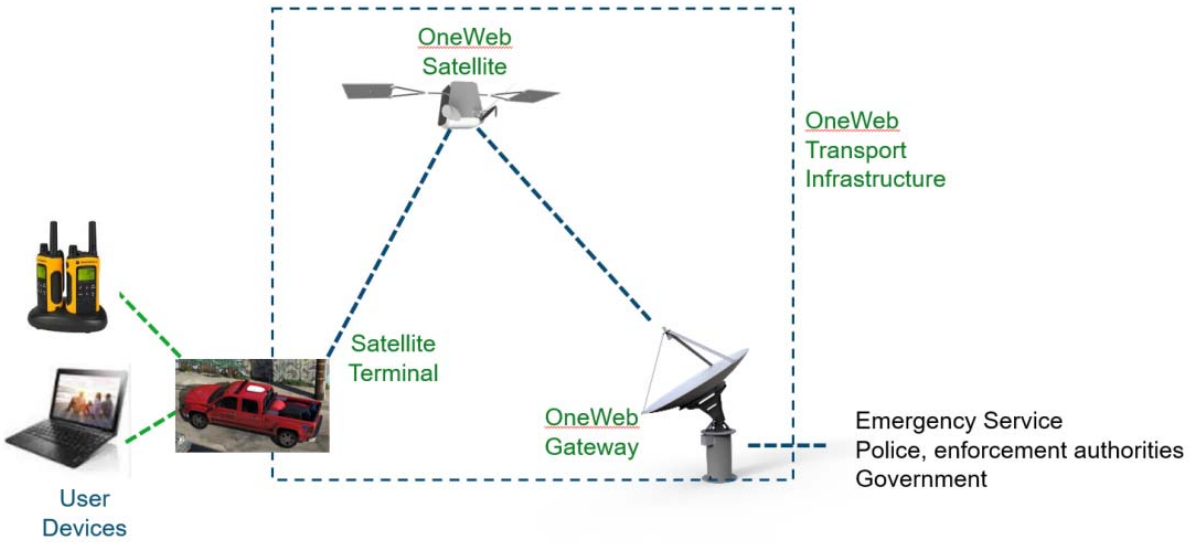


Figure 4: Basic Emergency and PPDR Model

7 Technical information

7.0 General

The described LEO NGSO satellite system is aimed at providing an affordable broadband service to fixed and in motion user terminals on land, at sea and in the air. The large capacity offered by such NGSO systems allows for a multitude of customized applications such as PPDR or the extension of cellular services to remote and rural areas that are underserved or not served at all. Currently these services, especially the services offered to aircraft or maritime applications, do not carry safety services.

One of the NGSO satellite systems to be deployed from 2018 uses Ku-band for the links between the satellites and user terminals and Ka-band for the feeder-links between the satellites and gateway earth stations, with the latter providing the interconnection to the global Internet. The system's Ku-band user terminals consist of small and inexpensive antennas (typically less than 1 m in diameter).

7.1 Detailed technical description

One of the NGSO satellite systems would initially consists of a constellation of 720 LEO satellites, plus in-orbit spares, growing to higher numbers over the years to increase capacity, in 18 near-polar circular orbits planes, as well as associated ground control facilities, gateway earth stations and user terminals. The orbit altitude will be 1 200 km and the orbit inclination 87,9°.

Because of the use of near-polar orbits, this constellation's satellites pass over all parts of the Earth's surface and therefore, in principle, have the ability to provide service to the entire planet as shown in figure 5. The system design is optimized to ensure user terminals, located anywhere on earth, to have an elevation not less than 55°, and this elevation further increases with latitude.

The use of a relatively large number of satellites and the choice of a polar orbit will facilitate the offering of innovative broadband services to high latitude regions of the world which have in the past had not been adequately served by satellites. In these high latitude regions, there will be a higher density of satellites than in equatorial regions.

The gateway feeder-links will connect the NGSO satellite system to the global internet. About 40 to 60 gateways are expected to be deployed for such a system to ensure that each satellite has a visible gateway earth station available for communication from all parts its orbit.

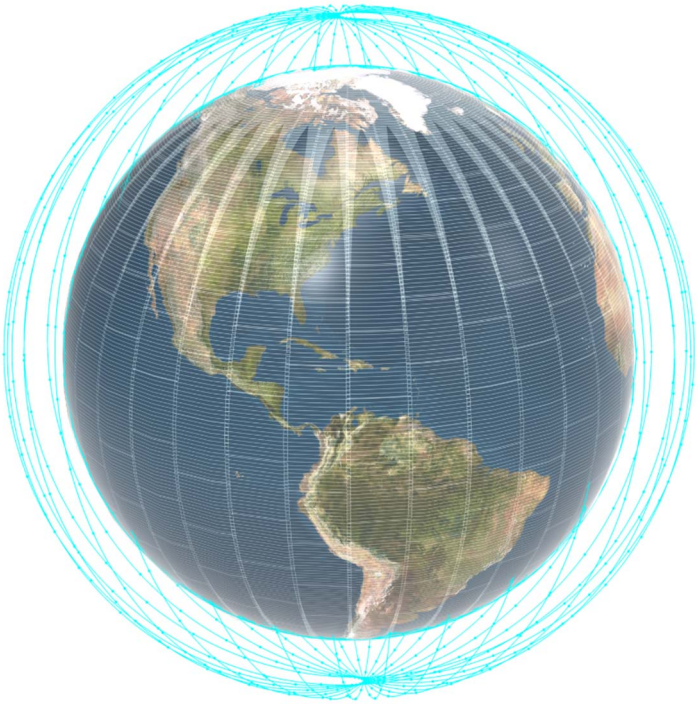


Figure 5: A LEO NGSO constellation of polar orbiting satellites

The system architecture is presented in figures 1 to 4 according to the market vertical considered.

The user terminals utilize the following frequencies:

- Transmit Frequencies (Earth to space) user terminal to satellite 14,0 GHz to 14,5 GHz (see note).
- Receive Frequencies (space to Earth) satellite to user terminal 10,7 GHz to 12,75 GHz.

NOTE: Other FSS allocations can also be used, as given in article 5 of the ITU Radio Regulations [i.20], such as the 12,75 GHz to 13,25 GHz.

The use of transmit frequencies of the terminals will depend on the national authorization. Such authorization will take into account all allocations within the band:

- The band 14 GHz to 14,5 GHz is allocated on a worldwide and primary basis to the fixed satellite service in the ITU Radio Regulations [i.20].
- The band 14,25 GHz to 14,5 GHz is allocated on a primary basis to the fixed service.
- The band 14,47 GHz to 14,5 GHz is allocated on a secondary basis to the radio astronomy service.

7.2 Technical parameters and implications on spectrum

7.2.0 General

Technical parameters of a LEO NGSO system operating at Ku band are described below. Specific technical parameters necessary for spectrum related discussions, those mainly related to user terminals, are presented.

The deployment of fixed Earth stations and ESIM will place a regulatory requirement to maintain compatibility with other services operating within the 14 GHz to 14,5 GHz band. This compatibility scenarios are also described below.

NGSO satellite systems operating in the Ku band are required protect the GSO networks in operation or those to be deployed in the future by complying with conditions set in the ITU RR. The main condition is the compliance with EPFD limits as per the ITU Radio Regulations [i.20], article 22 for both Earth to space and space to Earth links.

In addition, as the receive band of these NGSO terminals (10,70 GHz to 12,75 GHz) is shared with the fixed service, some care is required to avoid any interference from fixed stations. In many countries operations of the satellite terminals will be based on a non-protection basis, and as such interference is localized, it is then left to the satellite operator to manage the use of frequencies on a local basis.

In addition, care is required to avoid harmful interference to the radio astronomy service (RAS) in the adjacent band 10,6 to 10,7 GHz and the Earth Exploration Satellite Service (EESS) (passive) due to unwanted emissions from the satellites transmitting above 10,7 GHz. Studies and results for the RAS is provided in clause 7.2.1.2. Protection of the radio astronomy service in the band 10,6 GHz to 10,7 GHz will also protect the EESS (passive).

7.2.1 Status of technical parameters

7.2.1.1 Current ITU and European Common Allocations

Article 22 of the ITU Radio Regulations [i.20] stipulates that NGSO systems operating in the 10,70 GHz to 12,75 GHz and 14,0 GHz to 14,5 GHz bands should meet certain EPFD limits to provide protection to GSO networks. NGSO systems operating in these bands should comply with the Radio Regulations, therefore, protection of GSO networks will not require any further compatibility studies.

Current allocation of the Ku bands in the ITU Radio Regulations [i.20] is included in table 1, together with actual usage within the CEPT as given in the European Common Allocations. The information of table 1, i.e. extract from the European Common Allocations Table - ERC Report 25 [i.1], can be found in clause 9.1 of the present document.

7.2.1.2 Sharing and compatibility studies

At the time of drafting the present document, the sharing and compatibility studies between NGSO constellations and other systems are being studied within the CEPT/ECC Spectrum Engineering Working Group.

These compatibility studies presented in the ECC Report 271 [i.27] for user terminals used as fixed Earth stations include:

- Compatibility studies with fixed links deployed in some countries in the sub-band 14,25 GHz to 14,5 GHz band (see figure 6).
- Compatibility studies in the band 14,47 GHz to 14,5 GHz with the Radio Astronomy Service (RAS) which is allocated on a secondary basis (see figure 7).

The compatibility studies presented in the ECC Report 271 [i.27] for user terminals used as in-motion Earth stations, for air, land and maritime applications include:

- Compatibility studies with receivers of the fixed deployed in some countries in the sub-band 14,0 GHz to 14,5 GHz.
- Compatibility studies with the radio astronomy service (RAS) at 14,47 GHz to 14,5 GHz.

In addition, compatibility studies given in the ECC Report 271 [i.27] also include:

- Compatibility studies with radio astronomy observatories performing observations at 10,6 GHz to 10,7 GHz.
- Compatibility studies with the EESS (passive) remote sensing satellites in 10,6 GHz to 10,7 GHz.

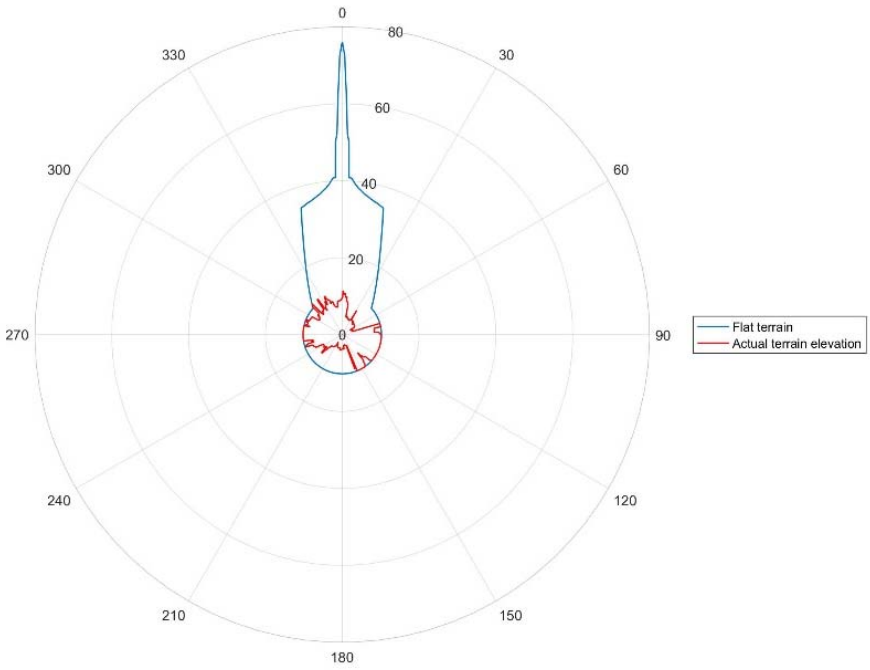
Results of Studies with Fixed Services in 14,25 GHz to 14,5 GHz (from the ECC Report 271 [i.27])

Separation contours have been determined around FS stations in order to protect them from harmful interference. The size of protection areas around FS stations varies a lot and needs to be determined on a case-by-case basis to take into account actual FSS and FS parameters and surrounding terrain by the administration where the FS station operates. With regard to airborne FSS earth stations, a PFD mask has been defined. See figure 6 which shows the comparison for a FS link pointing north. This gets to show that for a real FS link the separation distance is less than 10 km.

From the WGSE survey on FS links for the band 14,25 GHz to 14,5 GHz (SE19(16)75 Annex 2rev1 [i.26]) it is known that only the following countries have FS links in this band:

- France about 141 legacy links
- Germany about 30 legacy links
- Italy about 1 000 links
- Russia about 50 legacy links
- UK about 121 legacy links

In all countries, except Italy, such FS links have been drastically reducing year by year, since this band is not being used any longer for the deployment of FS links.



NOTE: Example is for an FS station pointing North located in UK.

Figure 6: Comparison of separation distance in the band 14,25 GHz to 14,5 GHz, between theoretical flat terrain and with terrain data model

Results of Studies with Radio Astronomy Service in 14,47 GHz to 14,5 GHz

Below are the results of analysis of maximum separation distance from RAS site in Cambridge UK and NGSO LEO satellite terminals in the band 14,47 GHz to 14,5 GHz. The size of protection areas around RAS stations varies a lot and needs to be determined on a case-by-case basis to take into account actual FSS and RAS parameters and surrounding terrain by the administration where the RAS station operates. With regard to airborne FSS earth stations, a PFD mask has been defined by WGSE.

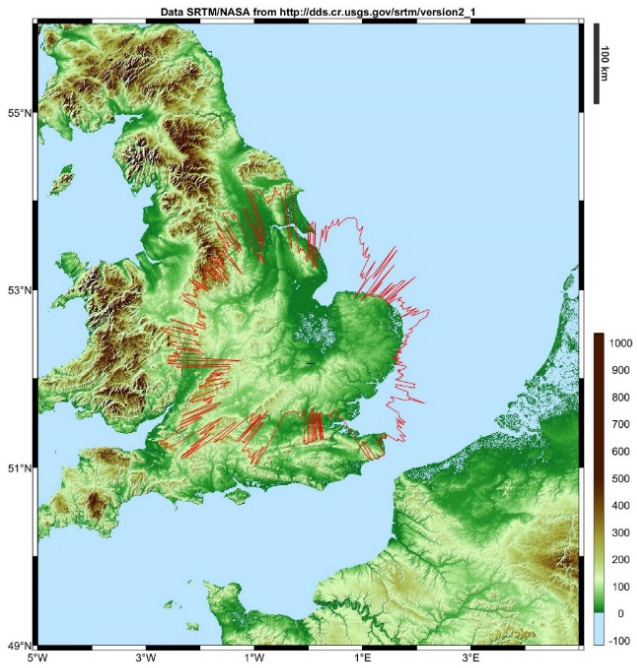


Figure 7: RAS at Cambridge (UK - max separation distance 235 km)

Results of Studies with Radio Astronomy Service and EESS (passive) in 10,6 GHz to 10,7 GHz (from ECC Report 271 [i.27])

EIRP limits have been defined for each satellite beam in order to meet a 2 % overall data loss specification over the sky. This also limits the average exceedance of the Recommendation ITU-R RA.769-2 [i.21] detrimental threshold levels to 1,5 dB whatever the pointing direction of the RAS observatory. Those EIRP limits per beam would also protect EESS (passive) sensors, with a large margin.

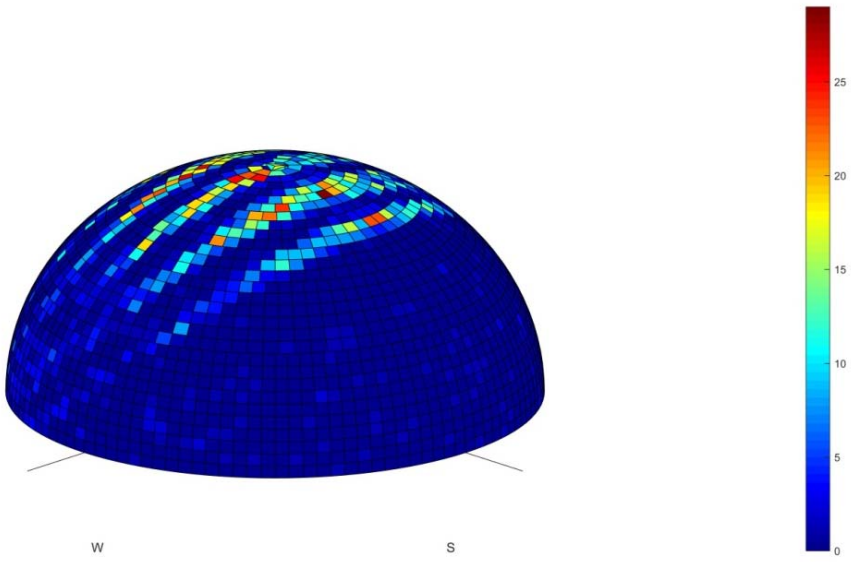


Figure 8: Percentage of data loss over the sky at Effelsberg (Germany) RAS observatory

Operations around airport fields

The electromagnetic compatibility between satellite terminals and aircraft in the vicinity of an airfield avionics has been examined in the ECC Report 66 [i.3]. Figure 4 of ECC Report 66 [i.3], provides the minimum distance that an Earth station should respect for the electric field not to exceed a given level. For example, for an electric field limit of 20 V/m (a limit for aircraft built before 1986), the minimum horizontal distance between an Earth station, with an EIRP of 37 dBW, and the touchdown point at a run-way when an aircraft is landing is about 370 meters. The minimum distance between the satellite terminal and the aircraft is 19,4 m.

Generally, the following coordination area in the vicinity of airports have been derived using the methodology described in ECC Report 66 [i.3] and a maximum EMC field strength of 20 V/m. The coordination zone is an area surrounding the boundary fence of the airport and this depends on the e.i.r.p. of the earth station as shown in table 1.

Table 1: Size of the coordination area around airfields

e.i.r.p.	≤ 34 dBW	> 34 to 37 dBW	> 37 to 40 dBW	> 40 to 45 dBW	> 45 to 50 dBW	> 50 to 55 dBW	> 55 to 60 dBW
Distance from airport boundary fence (see note)	0 m	220 m	380 m	780 m	1 500 m	2 800 m	5 100 m
NOTE: The distances given have been copied from the relevant ECC Decisions applicable to satellite terminals. Note that such distances should be applied from where the aircraft touches down the run-way and not from the airport fence. It is expected that this will be corrected when the ECC Report 66 [i.3] is modified.							

ECC Report 66 [i.3] is under review since the European safety agencies have provided recent comments on the safe EMC field strength threshold, suggesting that this should be greater than the assumed 20 V/m. With such input table 1 is expected to be modified and leading to much shorter distances.

7.2.2 Transmitter parameters

7.2.2.0 General

This clause provides transmitter parameters of user terminals operating to NGSO FSS satellite system in the 14,0 GHz to 14,50 GHz band. These transmitter parameters, applicable for all user terminals i.e. fixed and ESIM, are presented in table 2.

Table 2: Transmitter parameters

	Units	**Consumer Earth station**	**Enterprise Earth station**	**Notes**
Carrier Allocated Bandwidth (ABW)	MHz	20		6 carriers per transponder
Carrier Occupied Bandwidth (OBW)	MHz	18,2		
Symbol rate	MBds	18,2		
Data rate	Mbps	36,4		
Error Correction Coding		3GPP Turbo Convolutional Code		
Equivalent Parabolic Antenna Diameter	M	0,45	0,90	
Transmit Antenna Beamwidth	degrees	3,27	1,64	@ 14,25 GHz
Minimum Operational Elevation Angle	degrees	50 to 60		
Tx Antenna Gain (Gtx)	dBi	35	41	70 % Efficiency @ 14,25 GHz
Feeder Loss (Lf)	dB	1,0	1,0	
Power input into antenna	dBW	0	-6	The input power scales with the carrier bandwidth (10 MHz carriers would have an input power of -1 dBW for the Consumer UT)
e.i.r.p.	dBW	34	34	

Specific aspects of the transmitter parameters are discussed below.

7.2.2.1 Transmitter Output Power/Radiated Power

As shown in table 2 these user terminals will have a maximum EIRP of 34 dBW with antenna gain (depending on the type of user terminal) varying between 35 dBi and 41 dBi.

This part includes the transmitter characteristics of FSS earth stations operating in the bands 14,0 GHz to 14,50 GHz.

The typical transmitter parameters for user terminals of NGSO systems are given in table 1.

The reference transmit chain is: Modulator - High Power Amplifier - Antenna.

Transmission Mask (TM), (measured at modulator output): As specified in ETSI EN 301 428 [i.2] and subsequent updates.

Adjacent Channel Power (ACP): The adjacent channel power limitations are defined by the satellite operator and regulator and depend on the power class and type of terminal used.

Power Control (PC): Power control is an option in the user terminal and if implemented it is taken into account in the requirements of the UT as outlined in ETSI EN 301 428 [i.2].

7.2.2.2 Operating Frequency

As per the frequency plan presented in clause 7.1, FSS earth stations transmit in the bands 14,0 GHz to 14,5 GHz.

7.2.2.3 Bandwidth

Transmit bandwidth allocations depend on the achievable link budget (efficiency) as well as the required margins and the throughput to be achieved. The configurable range is:

- Minimum transmitter bandwidth allocation per user terminal: 1,4 MHz.
- Maximum transmitter bandwidth allocation per carrier and per user terminal: 20 MHz (40 MHz per Multi Frequency Time Division Multiplexing Access group of carriers).
- For transmitter bandwidths, less than 20 MHz the parameters in table 2 will scale accordingly, including a corresponding reduction in transmit power and e.i.r.p. for lower bandwidth carriers.

7.2.2.4 Spurious emissions

The user terminals working to Ku band NGSO satellite systems will comply with on-axis and off-axis spurious emissions limits given in clauses 4.2.3 and 4.2.4 of ETSI EN 303 980 [i.4], respectively.

The out-of-band emissions from the antenna are defined by the satellite system operator, as typical 1 dBW/4 kHz (ETSI EN 303 980 [i.4]).

7.2.3 Receiver parameters

This part includes the receiver characteristics of FSS earth stations operating in the bands 10,70 GHz to 12,75 GHz. See table 3 for the Receive baseline parameters (see ETSI EN 303 980 [i.4]).

Table 3: Receiver baseline parameters

Parameter	Description	Specification
LNB gain	Low Noise amplifier	55 dB to 65 dB (typical)
Typical system noise temperature	Reference system noise temperature used to evaluate the noise figure	290 K
Noise figure	Noise figure over the receive band range tuned to	1,5 dB maximum over tuned frequency band
Blocking	Maximum LNB input power aggregated allowed (above which non-linear region of LNB)	-75 dBm (typical) to -60 dBm (max)
Tuner flexibility	The receiver is adjusted to a specific part of the frequency band to optimize noise figure A segmentation of the frequency band into 250 MHz band regions is proposed	250 MHz (typical)

The receive parameters for the typical NGSO system are given in table 4.

Table 4: Receive Parameters

	Units	Consumer User Terminal	Enterprise User Terminal	Notes
Allocated Bandwidth (ABW)	MHz	250		
Occupied Bandwidth (OBW)	MHz	230,4		
Symbol rate	Msps	230,4		
Error Correction Coding		3GPP Turbo Convolutional Code		
Equivalent Parabolic Antenna Diameter	m	0,48	0,96	
Antenna Beamwidth	degrees	3,8	1,9	@ 11,7 GHz
Minimum Operational Elevation Angle	degrees	50-60		
Rx Gain (Grx)	dBi	32,1	38,2	@ 11,7 GHz
System Noise Temperature	K	200	200	
G/T	dB/K	9,3	15,3	Efficiency 70 % @ 11,7 GHz

7.2.4 Channel access parameters

These parameters are system level parameters and relate to the ability of the receiver to insert into the system context of a receiver that shares the frequency access with other receivers.

It is assumed that the end user terminal is capable of changing its frequency and modulation and coding parameters (physical layer channel parameters) on the forward (outbound) and on the return (inbound) link. The frequency, the modulation and coding as well as the transmit power settings can be changed as required by the system Network Control Centre (NCC).

The FSS earth station, the user terminal, has a reconfigurable air interface in forward and return link. The earth station is capable of accessing the frequency resources assigned by the system and to change its frequency assignments and power density parameters without losing the link to the system controlling gateway station.

The response time of the terminal to a change in its allocated capacity is defined as the "duty cycle" of the system, the time period required by the system to respond to a changing interference condition on the channel. Within the considered reference system, it should take about 1 second to change from one frequency carrier to another in order to minimize impact on the Quality of Service.

The typical minimal frequency agility on the transmit side of the terminal is defined to be at least 20 MHz.

7.2.5 User terminal parameters required for compatibility assessments

Technical parameters of LEO NGSO systems operating at Ku band necessary for maintaining compatibility with other services are presented below:

- User terminal antenna pattern, EIRP, including EIRP density towards the horizon.
- Ability to suppress transmissions from the user terminal, managed by the NCF.
- Uplink and down link EPFD compliance.

User terminal antenna pattern: The user terminal antenna pattern of one NGSO system to be deployed in 2018 is shown in figures 9 and 10. This system plans to maintain a minimum elevation of user terminal antenna [65 degrees] above the horizon. These user terminals operate with a maximum EIRP of 34 dBW (see table 2), and with a minimum channel bandwidth of 2 MHz.

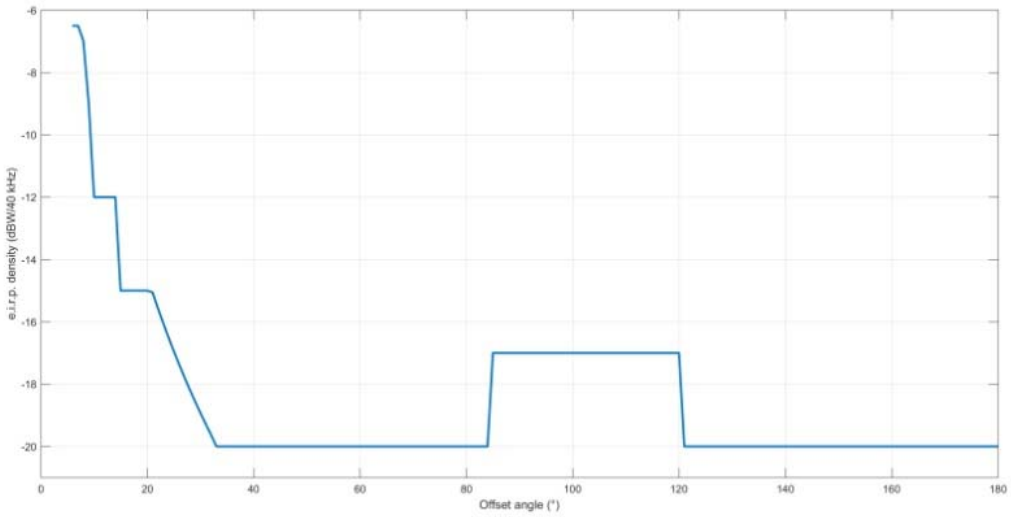


Figure 9: Antenna Pattern - EIRP mask for parabolic antenna

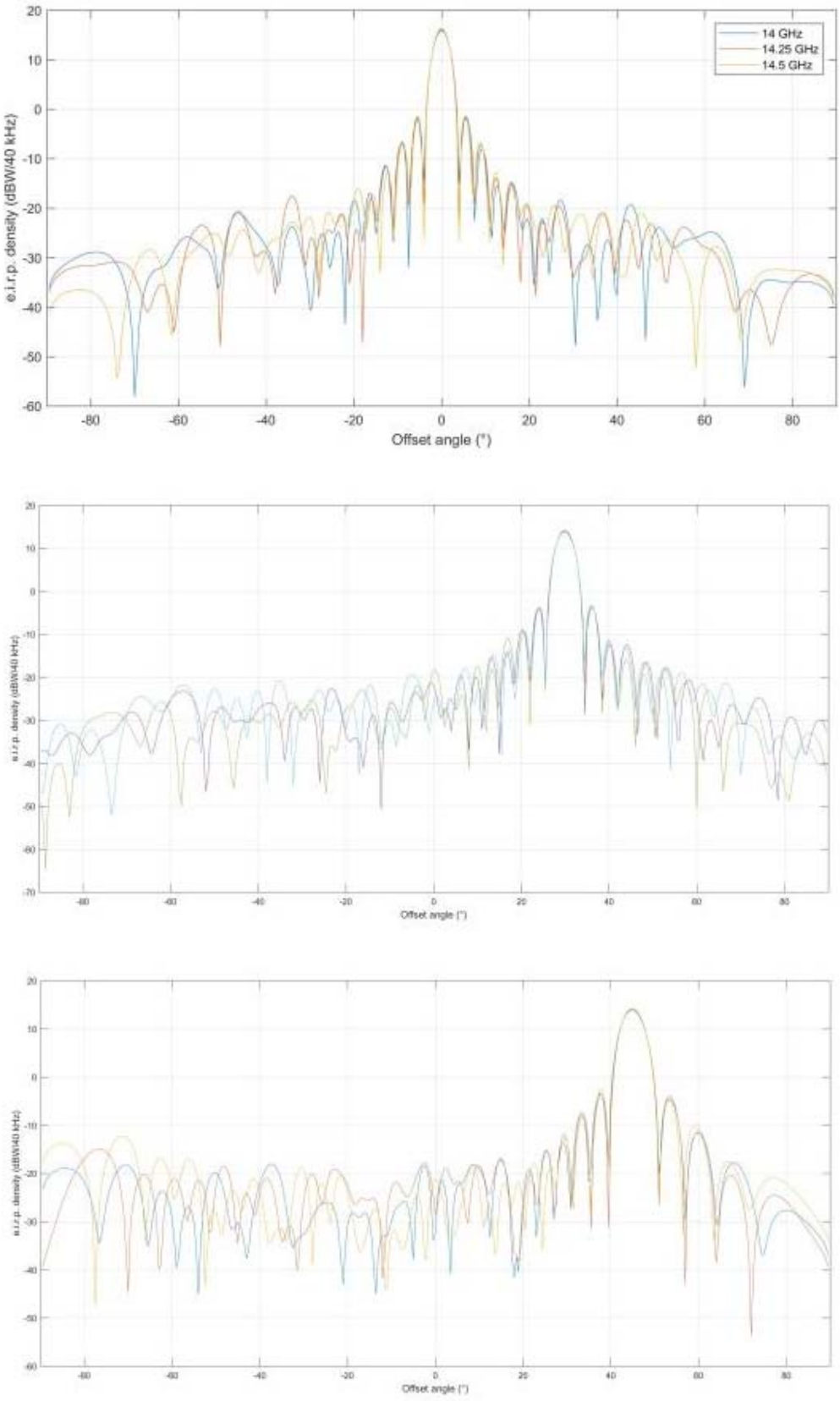


Figure 10: Antenna Pattern - EIRP mask for phased array antenna pointing at 0°, 30° and 45°

It is clear that the user terminals may be required to suppress transmissions if they create a potential to cause interference to other authorized services. This aspect has been considered in the preparation of the harmonised standard ETSI EN 303 980 [i.4]. This harmonised standard ETSI EN 303 980 [i.4] identifies in its clause 4.2.6.2.2 the conditions for cessation of emissions. These include, amongst others, the requirement for the NGSO system to determine the location of the earth station working to a NGSO satellite system (NEST), and the requirement for NEST to cease emissions prior to entering any protection zone (i.e. an area within such NEST transmissions in a specific frequency band is prohibited in order to protect another authorized service).

It has been shown that this system complies with the ITU specified EPFD criteria for both up and down links. Such criteria have been established by the ITU for the protection of GSO networks.

7.3 Information on relevant standard(s)

ETSI EN 303 980 [i.4] is at advanced stage of development.

8 Radio spectrum request and justification

The ECC decision currently being drafted by the FM44 group identifies frequency bands for the NGSO use. The current work item FM44_28 describes earth stations operating to NGSO systems in 10,7 GHz to 12,75 GHz (space to Earth) and 14 GHz to 14,5 GHz (Earth to space) FSS allocation (for fixed and moving platforms). This work item foresees:

- Developing 1) an ECC Report and 2) develop and/or amend ECC Decisions on harmonized use, exemption from individual licensing of fixed earth stations with NGSO FSS satellite systems in 10,7 GHz to 12,75 GHz (space to Earth) and 14 to 14,5 GHz (Earth to space).

Note that FM44 is still examining regulatory issues before deciding the way to proceed with in-motion earth stations operating with NGSO satellite systems in 10,7 GHz to 12,75 GHz and 14 GHz to 14,5 GHz:

- Identifying similarities and differences of existing GSO and NGSO ECC Decisions. Identify technical, regulatory and operational restrictions, define technical essential characteristics, define regulatory regime. The ECC Report should describe the reasoning for the ECC/DEC on NGSO E/S in 10,7 GHz to 12,75 GHz (space to Earth) and 14 GHz to 14,5 GHz (Earth to space) and technical compatibility results where required.

- Within Europe, it is recognized that the bands 12,75 GHz to 13,25 GHz (heavily populated) and 14,25 GHz to 14,5 GHz (lightly populated) are used by the Fixed Service (FS). These bands are also available for use by the FSS with the recognition that while the former band is extensively used by the fixed service, the latter band is not widely used. ECC should take account of the actual utilization of these FS allocations when studying the compatibility of NGSO terminals of Low Earth Orbiting (LEO) constellations with the fixed links. One should also study any mitigation techniques that could be adopted to accommodate the use of NGSO terminals in such bands. The results of such studies could be recorded in an ECC Report.

- The possibility of exemption from individual licensing should also be examined taking into account the sharing conditions and also other regulatory requirements for licensing specific terminals, such as those deployed for maritime and aeronautical applications.

- Only a few European countries have fixed microwave links in the 14,25 GHz to 14,5 GHz band, as presented in the liaison statement (SE19(16)75 Annex 2rev1 [i.26]):

  - e.g. France with 141; UK with 121, Germany less than 50, Russia about 30 FS links, and Italy many links;

  - in most countries use of the frequency band has been frozen (e.g. UK, France, Germany) for growth by FS links and existing FS links will be naturally phased out.

- Specific regulatory measures can be easily implemented (e.g. compliance with protection criteria specified as PFD limits or frequency coordination) to ensure that aircraft and maritime and vehicular Earth stations do not cause interference to fixed links. Earth Stations will comply with ETSI harmonised standard (ETSI EN 303 980 [i.4]).

9 Regulations

9.1 Current regulations

The EPFD limits as included in the ITU Radio Regulations [i.20] apply as prescribed in article 22.

A regulatory framework at ECC (ECC Decisions and ECC Reports) already exist in the 14,0 GHz and 27,5 GHz to 30 GHz for equipment at fixed and moving platforms.

Table 5: Extract from the European Common Allocations Table - ERC Report 25 [i.1]

10.7 GHz - 10.95 GHz	• FIXED • MOBILE EXCEPT AERONAUTICAL MOBILE • Mobile-Satellite (space-to-Earth) • FIXED-SATELLITE (EARTH-TO-SPACE) (5.484) • FIXED-SATELLITE (SPACE-TO-EARTH) (5.441)	• FSS Earth stations • HEST • LEST • AES • Fixed
10.95 GHz - 11.2 GHz	• FIXED • FIXED-SATELLITE (SPACE-TO-EARTH) (5.484A) (5.484B) • FIXED-SATELLITE (EARTH-TO-SPACE) (5.484) • MOBILE EXCEPT AERONAUTICAL MOBILE	• AES • Fixed
11.2 GHz - 11.45 GHz	• FIXED-SATELLITE (EARTH-TO-SPACE) (5.484) • MOBILE EXCEPT AERONAUTICAL MOBILE • FIXED • FIXED-SATELLITE (SPACE-TO-EARTH) (5.441)	• AES • Fixed
11.45 GHz - 11.7 GHz	• FIXED • FIXED-SATELLITE (EARTH-TO-SPACE) (5.484) • FIXED-SATELLITE (SPACE-TO-EARTH) (5.484B) (5.484A) • MOBILE EXCEPT AERONAUTICAL MOBILE	• Fixed • AES
11.7 GHz - 12.5 GHz (5.487) (5.487A) (ECA28)	• BROADCASTING-SATELLITE (5.492) • FIXED • MOBILE EXCEPT AERONAUTICAL MOBILE	• LEST • HEST • Broadcasting (satellite)
12.5 GHz - 12.75 GHz (5.496)	• FIXED-SATELLITE (EARTH-TO-SPACE) • FIXED-SATELLITE (SPACE-TO-EARTH) (5.484A) (5.484B)	• HEST • LEST • FSS Earth stations • AES
14 GHz - 14.25 GHz	• FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A)(5.457B)(5.506)(5.506B)(5.484B) • Mobile-Satellite (Earth-to-Space) (5.504B)(5.506A)(5.508A) • Space Research (5.504)	• AES • ESV • HEST • LEST • MSS Earth Stations • VSAT
14.25 GHz - 14.3 GHz	• FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A)(5.506B)(5.484A)(5.457B)(5.484B) • Mobile-Satellite (Earth-to-Space) (5.504B)(5.506A)(5.508A) • Space Research (5.504)	• AES • ESV • MSS Earth stations • VSAT
14.3 GHz - 14.4 GHz	• FIXED-SATELLITE (EARTH-TO-SPACE) (5.506)(5.457A)(5.506B)(5.484A)(5.457B)(5.484B) • Mobile-Satellite (Earth-to-Space) (5.504B)(5.506A)(5.509A)	• AES • ESV • FSS Earth stations • Fixed • MSS Earth station • VSAT

14.4 GHz - 14.47 GHz (5.504A)	• FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A) (5.484A) (5.506) (5.457B) (5.506B) (5.484B) • Mobile-Satellite (Earth-to-space) (5.504B) (5.506A) (5.509A)	• FSS Earth stations • ESV • AES • MSS Earth stations • VSAT
14.47 GHz - 14.5 GHz (5.149) (5.504A)	• FIXED-SATELLITE (EARTH-TO-SPACE) (5.457A) (5.484A) (5.506) • Mobile-Satellite (Earth-to-space) (5.504B) (5.506A) (5.509A) • Radio Astronomy	• VSAT • MSS Earth stations • ESV • FSS Earth stations • Radio astronomy • AES

This includes also the following list of harmonised standards for earth stations operating in the 10,7 GHz to 14,5 GHz:

- ETSI EN 302 186 Satellite mobile Aircraft Earth Stations (AESs) operating in the 11/12/14 GHz frequency bands [i.5];
- ETSI EN 301 428 Transmit-only, transmit/receive or receive-only satellite earth stations operating in the 11/12/14 GHz frequency bands [i.2];
- ETSI EN 301 459 SIT and SUT transmitting towards satellites in geostationary orbit in the 29,5 GHz to 30,0 GHz frequency bands [i.6];
- ETSI EN 301 360 SIT and SUT transmitting towards geostationary satellites in the 27,5 GHz to 29,5 GHz frequency bands [i.7];
- ETSI EN 301 430 Satellite News Gathering Transportable Earth Stations (SNG TES) operating in the 11-12/13-14 GHz frequency bands [i.8];
- ETSI EN 302 340 Satellite Earth Stations on board Vessels (ESVs) operating in the 11/12/14 GHz bands allocated to the Fixed Satellite Service (FSS) [i.9];
- ETSI EN 302 977 Vehicle-Mounted Earth stations (VMES) operating 14/12 GHz frequency bands [i.10];
- ETSI EN 301 427 Low data rate Mobile satellite Earth Stations (MESs) except aeronautical mobile satellite earth stations, operating in the 11/12/14 GHz frequency bands [i.11]; and
- ETSI EN 302 448 Earth Stations on Trains (ESTs) operating in the 14/12 GHz frequency bands [i.12].

This work to be undertaken by the ECC may take into account (but not limited to) the following existing ECC decisions:

- ECC/DEC/(06)02: Low EIRP Satellite Terminal [i.13];
- ECC/DEC/(06)03: High EIRP Satellite Terminal [i.14];
- ECC/DEC/(05)10: Earth Station of board Vessels (ESVs) [i.15];
- ECC/DEC/(05)11: Aeronautical Earth Stations (AESs) [i.16];
- ECC/DEC/(13)01: GSO ESOMPs for Ka-band [i.17]; and
- ECC/DEC/(15)04: NGSO ESOMPs for Ka-band [i.18].

Following documents are relevant to the NGSO equipment in Ku-band FSS allocations:

- ECC/DEC/(17)04: NGSO fixed Ku-band Satellite Terminal [i.19];
- ETSI Harmonised Standard ETSI EN 303 980: NGSO Satellite Terminals - Ku-band [i.4].

9.2 Proposed regulation and justification

Fixed Earth Stations operating with NGSO FSS satellite systems in the frequency band 10,7 GHz to 12,75 GHz (space to Earth) and 14,0 GHz to 14,5 GHz (Earth to space) are being planned to be deployed in Europe, as a part of worldwide deployment that will provide needed broadband and internet access to rural and remote areas. These Earth stations are generally intended to be deployed for ubiquitous fixed broadband applications and an ECC Decision is required to ensure that these terminals comply with the necessary technical requirements and to provide for the harmonised use, free circulation and exemption from individual licensing of the equipment within the CEPT.

ERC/REC 01-07 [i.23] that was adopted in 1995 listed harmonised criteria for administrations to decide whether an exemption of individual licence should be applied. This Decision, prepared within the aim of exempting Fixed Earth Stations operating with NGSO FSS satellite systems in the frequency band 14,0 GHz to 14,5 GHz from individual licensing, fulfils the criteria for exemption listed in ERC/REC 01-07 [i.23].

These NGSO systems provide a range of communications services with the main provision being broadband communication services. These Earth stations are fixed at a given location with antennas that track continuously the satellites in non-geostationary orbits and it is proposed that an ECC Decision considers terminals with a cumulative multicarrier EIRP of less than 37 dBW (34 dBW per carrier).

Licensing is an appropriate tool for administrations to regulate the effective use of the frequency spectrum and to avoid harmful interference. However, intervention from administrations as far as the installation and use of equipment is concerned needs to be proportionate. Administrations and especially users, retailers and manufacturers will benefit from a more deregulated system of authorizing (license exemption, harmonised use and free circulation) the use of radio equipment.

Article 5 of the Authorization Directive (Directive 2002/20/EC [i.24]) requires the use of spectrum, where risk of harmful interference is negligible, not to be subject to the grant of individual rights of use, but to include within general authorization. With the implementation of the Authorization Directive, administrations have exempted many radio equipment from individual licensing, including satellite terminals. The provision of Pan European services will be greatly assisted when all CEPT administrations would adopt similar criteria to exempt the same categories of radio equipment from individual licensing. Such criteria should only be based on conditions of harmful interference and the measures that could be adopted to mitigate the possibility of harmful interference, and therefore the installation and use of satellite terminals that are specifically identified as operating with power levels and operational conditions that are unlikely to cause harmful interference to other authorized services might be exempted from individual licensing and allowed free circulation of equipment.

Furthermore, the Radio Equipment Directive 2014/53/EU [i.22] places an emphasis on efficient and effective use of the spectrum. This is achieved by requiring the performance of the transmitter, as well as its receiver, meeting certain performance specifications. The relevant ETSI harmonised standards carry such specifications on both receiver and transmitter parameters.

The band 14 GHz to 14,5 GHz band is allocated on a worldwide and primary basis to the FSS (space to Earth) in the ITU Radio Regulations [i.20] is general available for satellite services within the CEPT and elsewhere. The band 14,25 GHz to 14,5 GHz band is used by a small number of point-to-point legacy microwave links of the Fixed Service in a limited number of CEPT countries. The CEPT/ERC/REC 13-03 E [i.25] (The Hague 1996) on the use of the band 14,0 GHz to 14,5 GHz for VSAT and Satellite News Gathering recommended that the use of the band 14,25 GHz to 14,5 GHz for the Fixed Service should be discouraged in those countries that have not already implemented fixed radio links in the band. In addition, the Recommendation said that flexible and unrestricted use of VSAT and SNG applications in the band 14,25 GHz to 14,5 GHz should be allowed at least in those countries where no fixed links have been implemented so far. Subsequently, the Decision ECC/DEC/(03)04 was adopted and it provides for licence exemption of VSAT operating in the 14,25 GHz to 14,5 GHz with e.i.r.p. of no more than 50 dBW subject to the conditions stipulated in the said ECC Decisions. The same conditions should apply for the Fixed Earth stations operating to NGSO satellite systems, even because there are mitigating factors that would lower the potential interference viz-a-viz GSO Earth stations, such as lower e.i.r.p., higher elevation angles and dynamic pointing of the satellite terminals to the NGSO satellites. Eventually legacy FS links will either be no more or will be removed and the relevant Administrations should make these band available under the same conditions existing in the 14,0 GHz to 14,5 GHz range. In the meantime, such Administrations should consider transitional measure that would allow uncoordinated use of the 14,25 GHz to 14,5 GHz band while avoiding harmful interference to the few legacy FS links.

The electromagnetic compatibility between satellite terminals and aircraft in the vicinity of an airfield avionics has been examined in the ECC Report 66 [i.3]. Figure 4 of ECC Report 66 [i.3], provides the minimum distance that an Earth station should respect for the electric field not to exceed a given level. For example, an electric field limit of 20 V/m (a limit for aircraft built before 1986), the minimum horizontal distance between an Earth station, with an EIRP of 37 dBW, and the touchdown point at a run-way when an aircraft is landing is about 370 meters. The minimum distance between the satellite terminal and the aircraft is 19,4 m. Therefore it is clear that satellite earth stations with an EIRP of less or equal to 37 dBW can operate beyond the airport perimeter without any constraints. Operations within an airfield is also possible but will require clearance with the respective airport authorities. In recent discussions within FM44 it was found that very conservative criteria of 20 V/m have been adopted for aircraft protection in ECC Report 66 [i.3]. Recent consideration by the Aeronautical Safety community (i.e. European Aviation Safety Agency) have proposed to FM44 that a EMC criteria of -190 V/M should be used in such studies (for the frequency range between 11 GHz to 18 GHz). In such case, for the an EIRP of 37 dBW, the horizontal distance of 220 m would fall to about 39 m. The minimum distance between the satellite terminal and the aircraft is 2 m. This is also well inside an airport field and as such the operation of the equipment does not have to be restricted outside the airport perimeter. The ECC Report 66 [i.3] or its conclusions are likely to be soon revised by FM44.

History

Document history		
V1.1.1	April 2019	Publication