# ECC Report 299

Measures to address potential blocking of MES operating in bands adjacent to 1518 MHz (including 1525-1559 MHz) at sea ports and airports

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## 0 EXECUTIVE SUMMARY

ECC Report 263 [1] identified that there may be a need to provide proportionate protection measures to Mobile Earth Stations (MESs) at seaports and airports, and hence ECC PT1 decided to create a work item with the following scope: “Study potential blocking of MES receivers caused by MFCN (SDL base stations) below 1518 MHz. MESs may need to show correct functioning in bands adjacent to 1518 MHz (including 1525-1559 MHz), as part of operational procedures, prior to departure from sea ports or airports. Propose proportionate solutions to address this issue."

To minimise any potential blocking of next generation MES receivers, CEPT concluded in ECC Report 263 that the minimum in-band blocking characteristic for land mobile earth station receivers from a 5 MHz broadband signal interferer (LTE) operating below 1518 MHz shall be −30 dBm above 1520 MHz, noting that the IMT block ends at 1517 MHz. The same blocking requirement as used for land mobile is assumed for next generation maritime and aeronautical MESs. This Report also addresses proportionate solutions for currently operating maritime and aeronautical MESs, that do not meet this blocking requirement.

This ECC Report has considered proportionate solutions that CEPT members could implement to address potential blocking of L-band maritime and aeronautical MES receivers in specific areas or locations. This report has identified certain maritime and aeronautical applications that administrations may wish to take into account in determining airports and seaports for application of the proportionate measures. Regarding maritime operations, administrations may choose to provide protection based on GMDSS services, which operate in the band 1530-1544 MHz, noting that this may also protect other maritime MSS operations outside this band if used at the same seaports. Regarding aeronautical operations, administrations may choose to provide protection based on AMS(R)S services, which operate in the band 1525-1559 MHz, noting that this may also protect other aeronautical MSS operations outside this band if used at the same airports. If administrations also provide protection of MSS applications which are operating outside the GMDSS/ AMS(R)S bands, this may require protection measures at additional seaports/airports, but the pfd values recommended in this Report remain unchanged.

Each national administration will decide which areas or locations require protection and how to do so, e.g. by using options outlined in Section 5 of this report if suitable to their national circumstances.

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# LIST OF ABBREVIATIONS

| Abbreviation | Explanation |
|---|---|
| **3G** | 3rd Generation |
| **ACARS** | Aircraft Communications Addressing and Reporting System |
| **ADS-B** | Automatic Dependent Surveillance-B |
| **ADS-C** | Automatic Dependent Surveillance-Contract |
| **AES** | Aircraft Earth Station |
| **agl** | above ground level |
| **AMS(R)S** | Aeronautical Mobile Satellite (Route) Service (AMSS used for aeronautical safety services) |
| **AMSS** | Aeronautical Mobile-Satellite Services |
| **ARINC** | Aeronautical Radio, Incorporated |
| **ATM** | Air Traffic Management |
| **BER** | Bit Error Rate |
| **BS** | Base Station |
| **BW** | Bandwidth |
| **CEPT** | European Conference of Postal and Telecommunications Administrations |
| **CIRM** | International Radio-Maritime Committee |
| **COSPAS-SARSAT** | Space System for Search of Distress Vessels - Search and Rescue Satellite-Aided Tracking |
| **CPDLC** | Controller Pilot Data Link Communications |
| **dB** | Decibel |
| **dBi** | Decibel relative to an Isotropic antenna |
| **dBm** | Decibel relative to 1 mW |
| **dBW** | Decibel relative to 1 W |
| **e.i.r.p.** | equivalent isotropic radiated power |
| **EASA** | European Aviation Safety Agency |
| **ECC** | Electronic Communications Committee |
| **EGC** | Enhanced Group Calling System |
| **EMSA** | European Maritime Safety Agency |
| **EPIRB** | Emergency Position-Indicating Radio Beacon |
| **ESA** | European Space Agency |
| **ETSI** | European Telecommunications Standards Institute |
| **EUROCAE** | European Organisation for Civil Aviation Equipment |

| Abbreviation | Explanation |
|---|---|
| **FANS** | Future Air Navigation System |
| **FB** | Fleet Broadband |
| **FCC** | Federal Communications Commission |
| **GMDSS** | Global Maritime Distress and Safety System |
| **GOLD** | Global Operational Data Link Document |
| **HF** | High Frequency |
| **IATA** | International Air Transport Association |
| **ICAO** | International Civil Aviation Organization |
| **ICS** | International Chamber of Shipping |
| **IEC** | International Electrotechnial Commission |
| **IMO** | International Maritime Organization |
| **IMT** | International Mobile Telecommunications |
| **IOC** | Initial Operational Capability |
| **ITU** | International Telecommunication Union |
| **K** | Kelvin |
| **kHz** | Kilohertz (1000 oscillations per second) |
| **LNA** | Low Noise Amplifier |
| **LRIT** | Long Range Identification and Tracking of ships |
| **LRIT** | Long Range Identification and Tracking |
| **LTE** | Long Term Evolution |
| **MCL MASPS** | Minimum Coupling Loss Aviation System Performance Standards |
| **MED** | Maritime Equipment Directive 2014/90/EU |
| **MES** | Mobile Earth Station |
| **MF** | Medium Frequency |
| **MFCN** | Mobile/Fixed Communications Networks |
| **MFCN ILS** | International Mobile TelephonyInstrument Landing System, as defined in Annex 10 to the ICAO Convention on International Civil Aviation, Volume I - “International Standards, Recommended Practices and Procedures for Air Navigation Services: Aeronautical Telecommunications”, |
| **MHz** | Megahertz (1000000 oscillations per second) |
| **MMEL** | Master Minimum Equipment List |
| **MOPS** | Minimum Operational Performance Specification |
| **MSI** | Maritime Safety Information |
| **MSS** | Mobile-Satellite Service |
| **NAVTEX** | Navigational Telex |
| **NCSR** | Navigation, Communications and Search and Rescue |

| Abbreviation | Explanation |
| --- | --- |
| **OOB** | Out of Band/Out of Block |
| **OOBE** | Out of Band Emissions/Out of Block Emissions |
| **PFD** | Power Flux Density |
| **PSC** | Port State Control |
| **RAINWAT** | Regional Arrangement on the Radiocommunication Service for Inland Waterways |
| **RED** | Radio Equipment Directive 2014/53/EU |
| **RF** | Radio Frequency |
| **RSCOM** | Radio Spectrum Committee |
| **RTCA** | Radio Technical Commission for Aeronautics |
| **Satcom** | Satellite Communications |
| **SAW** | Surface Acoustic Wave |
| **SB** | Swift Broadband |
| **SDL SSAS** | Supplementary Downlink Ship Security Alerting Systems |
| **SDO** | Standards Development Organisation |
| **SESAR** | Single European Sky ATM Research |
| **SNR** | Signal to Noise Ratio |
| **SOLAS** | Safety of Life at Sea |
| **SSAS** | Ship Security Alerting System |
| **STC** | Supplementary Type Certificate |
| **TSO** | Technical Standard Orders |
| **VHF** | Very High Frequency |
| **VMS** | Vessel Monitoring Systems |
| **WRC** | World Radiocommunication Conference |

# 1 INTRODUCTION

This Report is complementary to ECC Report 263 [1], which addresses the compatibility studies between MFCN base stations operating below 1518 MHz and MSS land terminals operating above 1518 MHz.

ECC Report 263 concluded that:

- The minimum in-band blocking characteristic for land mobile earth stations receivers from a 5 MHz broadband signal interferer (LTE) operating below 1518 MHz shall be −30 dBm above 1520 MHz;
- The base station unwanted emission limits e.i.r.p. for a broadband signal interferer (LTE) operating below 1518 MHz shall be −30dBm/MHz above 1520 MHz. This figure is 10 dB more stringent than ECC Decision (13)03 [26] due to a different service in the adjacent band.

It was noted that the IMT block ends at 1517 MHz.

MFCN harmonisation measures for usage of MFCN SDL below 1518 MHz have been developed under these assumptions and recently adopted (see ECC DEC Decision (17)06 [2] and EC Decision (EU) 2015/750[3] ).

Relevant measures will be implemented through the relevant harmonised standards in order to improve the receiver blocking characteristics of MES operating above 1518 MHz according to the conclusion of the ECC Report 263 and to the request sent to ETSI in January 2017 and June 2017. The request for ETSI to develop harmonised standards is related to the Radio Equipment Directive (RED) [4]. Equivalent standards related to the Maritime Equipment Directive (MED), which applies to new, type-approved marine equipment, mutually-recognised within the EU, either by ETSI or IEC, are required.

In addition, ECC Report 263 identified that there may be a need to provide proportionate protection measures to MESs at seaports and airports, and hence there may be a need to apply other mitigation techniques to MFCN BSs in the vicinity of seaports and airports for the frequencies at the top end of the 1492-1518 MHz frequency band to avoid harmful interference to MESs. In consequence, CEPT has developed this study on potential blocking of MES receivers caused by MFCN (SDL base stations) operating below 1518 MHz. These MES may need to show correct functioning in bands adjacent to 1518 MHz (including 1525-1559 MHz), as part of operational procedures, prior to departure from sea ports or airports.

The main activities in this Report are:

- to assess the state of the art of MES aeronautical and maritime terminals, in particular blocking measurements of these terminals;
- to provide the relevant background for aeronautical and maritime applicable international regulatory framework with a focus on aeronautical and maritime operational procedures, including those required prior to departure from sea ports or airports (NB: the situation along routes approaching or departing from destinations has not been addressed);
- to assess the timing and steps for the introduction of MFCN below 1518 MHz and relevant protection of MES terminals in adjacent bands, including the need and availability of improved MES receivers (not based on the natural obsolescence of the device) taking into account the rules within the IMO;
- to help administrations define the proportionate measures for protecting maritime and aeronautical safety communications and MES terminals at seaports and airports prior to departure from sea ports or airports.

Each national administration exercising its sovereign rights over its land territory, territorial sea and air space in the field of frequency management will decide which areas or locations require protection and how to do so, e.g. by using options outlined in this Report if suitable to their national circumstances.

## 2 CURRENT MES TERMINALS

The MSS L-band is used by several MSS systems, including those operated by Inmarsat and Thuraya. Inmarsat maritime services operate over several types of L-band MES terminals, the most widely used being “Inmarsat C”, “Mini C”, “Fleet 77” and “FleetBroadband.”

Inmarsat also provides three main types of L-band aeronautical services, known as “Classic Aero,” “Swift 64” and “SwiftBroadband”.

These maritime and aeronautical MESs currently receive in all or a part of the MSS L-band.

**Table 1: Number of Inmarsat terminals currently deployed**

| Services | | Approximate Number of Terminals in use |
|---|---|---|
| SEA | Inmarsat C (Maritime) | 160000 |
| | FleetBroadband | 56000 |
| | Fleet-77 | 11000 |
| AIR | Classic Aero | 9000 |
| | Swift Broadband | 9000 |
| | Swift 64 | 7000 |

The performance of an example of a potential MES receiver filter is shown below in Figure 1 (ECC Report 263 [1] concluded that the minimum in-band blocking characteristic for land mobile earth stations receivers from a 5 MHz broadband signal interferer (LTE) operating below 1518 MHz shall be −30 dBm above 1520 MHz). Note that this example meets the performance requirements for Inmarsat systems established on the basis of the previously settled electromagnetic environment in the band 1518-1559 MHz and. although the typical curve appears to provide some attenuation in the 1500-1510 MHz region, the mask (straight lines) actually guarantees no attenuation at all above 1490 MHz.

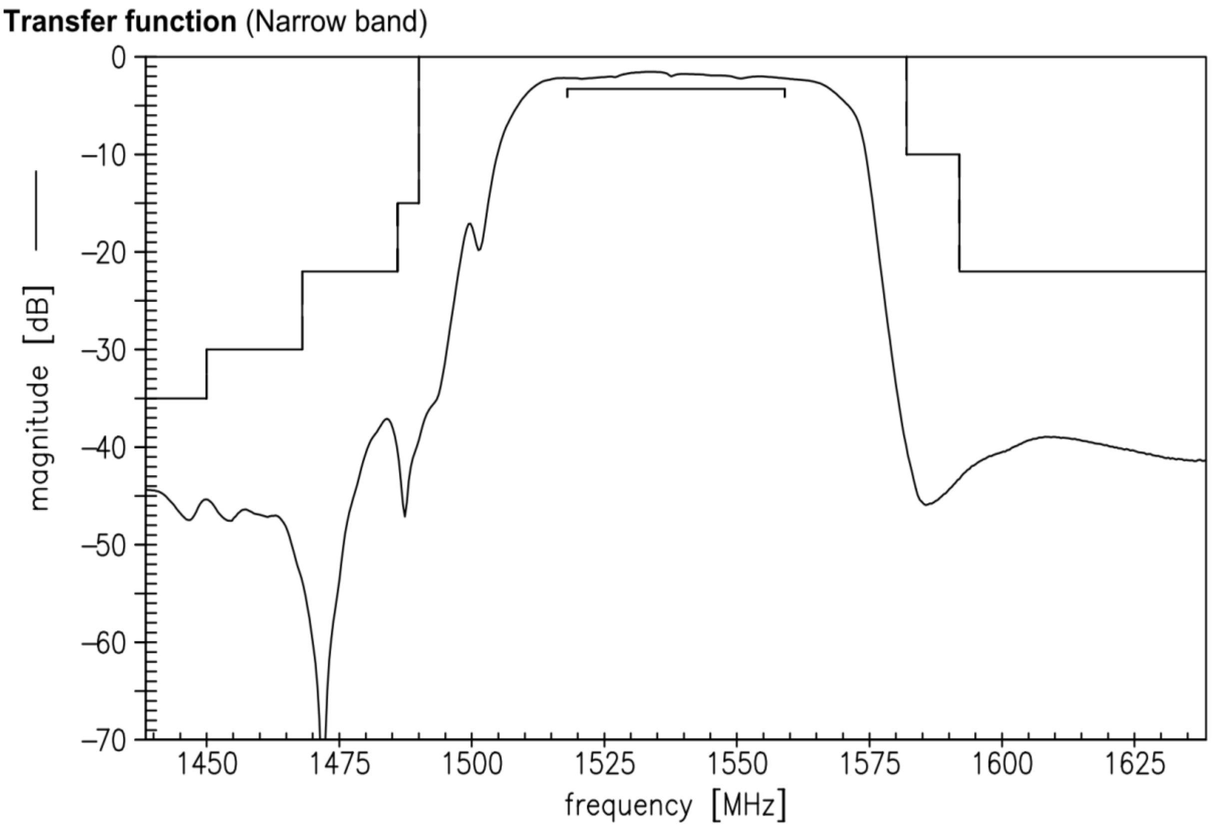


**Figure 1: Typical satellite receiver front-end SAW filter response**

Aeronautical terminals use front end filters conforming to performance requirements defined in ARINC characteristics 741 [13] and 781 [15]. These characteristics specify no selectivity requirement above 1450 MHz

The responses of different types of current maritime and aeronautical terminals to blocking/overload disturbances were measured by several Satcom (satellite communications) manufacturers against single and multiple (adjacent) LTE channels. The onset of terminal blocking - the "blocking performance" - resulting from a single LTE channel was measured by simulating an MFCN BS transmitting a single 5 MHz LTE channel at 1512-1517 MHz. The terminal blocking performance against multiple LTE channels was measured by simulating an MFCN BS transmitting simultaneously combinations of the following LTE channels: (1) a 5 MHz LTE channel at 1512-1517 MHz, (2) a 10 MHz LTE channel at 1502-1512 MHz and (3) a 10 MHz LTE channel at 1492-1502 MHz. The relative levels of these LTE signals have been chosen such that signal in block (1) is lower than the signals in blocks (2) and (3), reflecting the lower e.i.r.p. limit that applies to the use of channel (1) in CEPT.

The blocking performance measurements for multiple LTE channels were conducted in a laboratory with contiguous LTE carriers for different bandwidths (as interference sources), resulting in different LTE signals transmitted. The results of such studies may not be taken directly as representing a realistic scenario since these different signals are not likely to be radiated with the same power at the same time and be subject to the same propagation conditions (multi-paths & coherence band conditions).

The blocking performance has been considered to represent the condition when a 1 dB loss in receiver sensitivity occurs.

All signal levels are given for the reference point at the MES receiver/antenna connector and take into account diplexer filtering.

## 2.1 BLOCKING PERFORMANCE LEVELS FOR CURRENT AERONAUTICAL MES TERMINALS

The blocking performance levels for a number of current aeronautical earth stations (AES) - Classic Aero and Swift Broadband (SB) terminals - have been measured. The list of terminal types tested is shown in Table 2 below. The AES terminal types E, F, G and H are the most widely deployed for air transport.

**Table 2: Types of aeronautical terminals tested**

| Aeronautical Terminal Types | Service | Operational Band |
|---|---|---|
| AES A | Classic Aero and SB | 1525-1559 MHz |
| AES B | Classic Aero and SB | 1525-1559 MHz |
| AES C | Classic Aero and SB | 1525-1559 MHz |
| AES D | Classic Aero and SB | 1525-1559 MHz |
| AES E | Classic Aero and SB | 1525-1559 MHz |
| AES F | Classic Aero and SB | 1525-1559 MHz |
| AES G | Classic Aero | 1530-1559 MHz |
| AES H | Classic Aero | 1530-1559 MHz |

Summaries of the measured blocking performance results against single and multiple LTE channels are given in the sections below.

### 2.1.1 Blocking performance results from a single LTE channel transmission

The blocking performance for each of the AESs terminals listed above in Table 2 above was measured against a single 5 MHz LTE channel at 1512-1517 MHz, and a summary of the results for the most susceptible terminals Classic Aero (AES E) and SB (AES B) are presented in Table 3 below.

**Table 3: Measured blocking performance levels for Classic aero (AES E) and SB (AES B) resulting from a single LTE channel**

| Terminal Type | Blocking performance (dBm) | Wanted carrier Frequency (MHz) |
|---|---|---|
| Classic Aero (AES E) | -50.3 | 1555.1 |
| SB (AES B) | -40.8 | 1525.1 |

It is important to note that transmissions from LTE channels below 1512 MHz also cause blocking of the terminals. To illustrate this, the blocking performance levels for Classic Aero (AES E) and SB (AES B) were also measured against an LTE channel at different channels below 1512 MHz and the results are shown in Table 4 below.

**Table 4: Measured blocking performance levels for the most susceptible Classic aero (AES E) and SB (AES B) from a single 5 MHz LTE channel at different frequency centres**

| LTE Centre frequency (MHz) | Blocking performance of classic aero (AES E) (dBm) | Blocking performance of SB (AES B) (dBm) |
|---|---|---|
| 1514.5 | -50.3 | -40.8 |
| 1509.5 | -35 | -25.7 |
| 1504.5 | -35 | >-20 |
| 1499.5 | --25 | >-20 |

### 2.1.2 Blocking performance results from multiple LTE channel transmissions

The blocking performance levels for each of the AESs listed in Table 2 have also been measured against multiple LTE channels simultaneously transmitting, and the results for the most susceptible Classic aero (AES E) are shown in Table 5 below for two cases: (1) the three uppermost LTE channels in use; and (2) the two uppermost LTE channels in use.

**Table 5: Measured blocking performance levels for Classic Aero (AES E) (most susceptible AES) from multiple LTE channels**

| Case | Measured blocking performance from LTE channel at 1492-1502 MHz (dBm) | Measured blocking performance from LTE channel at 1502-1512 MHz (dBm) | Measured blocking performance from LTE channel at 1512-1517 MHz (dBm) |
|---|---|---|---|
| (1) | -48.4 | -48.4 | -55.5 |
| (2) | Not tested* | -45.6 | -55.5 |
| * For case (2), there was no signal generated in the channel 1492-1502 MHz. | | | |

## 2.2 BLOCKING PERFORMANCE LEVELS FOR CURRENT MARITIME MES TERMINALS

### 2.2.1 Blocking performance results from a single LTE channel transmission

Three different models of Inmarsat C and Fleet Broadband (FB) have been measured against a single 5 MHz LTE channel at various LTE centre frequencies between 1512 and 1517 MHz, and the results are presented in Table 6 below. Also presented are the approximate number and the year of production of each model, and the frequency at which the blocking test was carried out.

**Table 6: Measured blocking performance levels for models of current Inmarsat C and FB maritime terminals from a single LTE channel**

| Terminal type | Measured blocking performance (dBm) | Appx. Numbers of terminals | % models within type | Production Year | Wanted carrier test frequency (MHz) |
|---|---|---|---|---|---|
| Inmarsat C Model 1 | -76 to -71 | 59000 | 37% | 1995–2005 | 1537 |
| Inmarsat C Model 2 | -63 to -57 | 24000 | 15% | 1992–1995 | 1537 |
| Inmarsat C Model 3 | -34 to -30 | 77000 | 48% | 2005–2018 | 1537 |
| FB Model-1 | -62 | 17000 | 30% | 2005–2013 | 1525.1 |
| FB Model-2 | -38 | 8000 | 14% | 2007–2014 | 1525.1 |
| FB Model-3 | -30 | 31000 | 55% | 2012–2018 | 1525.1 |

Table 7 and Table 8 show the impact of interference from additional (lower frequency) LTE channels below 1517 MHz to Inmarsat C Model 1 and Model 2 respectively.

**Table 7: Measured Inmarsat C (Model 1) blocking performance resulting from a single LTE channel at three different frequencies**

| Terminal | Measured blocking performance levels from LTE channel at 1492-1502 MHz (dBm) | Measured blocking performance levels from LTE channel at 1502-1512 MHz (dBm) | Measured blocking performance levels from LTE channel at 1512-1517 MHz (dBm) |
|---|---|---|---|
| Model 1 | -53 | -68 | -76 |

**Table 8: Measured blocking performance levels for Inmarsat C model-2 from a single 5 MHz LTE channel at different frequency centres**

| LTE Centre frequency (MHz) | Measured blocking performance from LTE channel (dBm) | Test frequency (MHz) |
|---|---|---|
| 1509.5 | -50 | 1537 |
| 1504.5 | -41 | 1537 |
| 1499.5 | -36 | 1537 |
| 1494.5 | -32 | 1537 |
| 1489.5 | -24 | 1537 |
| 1484.5 | -20 | 1537 |

### 2.2.2 Blocking performance results from multiple LTE channel transmissions

The blocking performance levels for the most susceptible models, Inmarsat C Model 1, Model 2 and FB Model 1, have also been measured against multiple LTE channels transmitting simultaneously from one MFCN BS for two cases: (1) the three uppermost LTE channels in use; and (2) the two uppermost LTE channels in use, and the results are presented in Table 9 below.

**Table 9: Measured blocking performance levels for Inmarsat C Model-1, Model-2 and FB Model-1 from multiple LTE channels**

| Case | Terminal Type/Model | Measured blocking performance from LTE channel at 1492-1502 MHz (dBm) | Measured blocking performance from LTE channel at 1502-1512 MHz (dBm) | Measured blocking performance from LTE channel at 1512-1517 MHz (dBm) |
|---|---|---|---|---|
| (1) | FB Model-1 | -57 | -57 | -64 |
| (2) | | Not tested* | -55 | -65 |
| (1) | Inmarsat C Model 1 | -70 | -70 | -77 |
| (2) | | Not tested* | -67 | -78 |
| (1) | Inmarsat C Model 2 | -55 | -55 | -63 |
| (2) | | Not tested* | -52 | -63 |

* For case (2), there was no signal generated in the channel 1492-1502 MHz

# 3 OPERATIONAL REQUIREMENTS

## 3.1 AERONAUTICAL

Since the early 1990s, aeronautical L-band (1525-1559 MHz) MSS have been incorporated into the Future Air Navigation System (FANS 1/A) to provide direct data link communications between the aircraft and Air Traffic Control, which together with satellite voice communications allow for the safe separation of aircraft in oceanic and remote airspace when out of range of terrestrial surveillance (civil aviation radar and/or ADS-B) and terrestrial data and voice communications.

FANS 1/A services are provided via ADS-C (Automatic Dependent Surveillance-Contract) and for data link communications via CPDLC (Controller Pilot Data Link Communications), for which globally harmonised guidance and information is provided by the International Civil Aviation Organization (ICAO) via the Global Operational Data Link Document (GOLD).

EASA (European Aviation Safety Agency) regulations govern the operations of airlines based in the European Union. Specifically EASA regulation CAT.IDE.A.105 [5] states:

- CAT.IDE.A.105 Minimum Equipment for Flight;
- A flight shall not be commenced when any of the aeroplane’s instruments, items of equipment or functions required for the intended flight are inoperative or missing, unless;

  a) the aeroplane is operated in accordance with the operator’s MEL (Minimum Equipment List); or

  b) the operator is approved by the competent authority to operate the aeroplane within the constraints of the master minimum equipment list (MMEL).

The MMEL (Master Minimum Equipment List) as approved by EASA at the time of aircraft type certification defines what the aircraft is allowed to do or not do if a piece of equipment is not functioning in relation to the safety and regularity of flight operations. This can range from not flying, landing immediately, etc. to carrying more fuel.

FANS equipment is typically included in the MMEL for aircraft which will operate on FANS routes and in the MEL for the airline. In order to comply with regulations, including those above, it is standard and necessary procedure to verify that all required equipment and systems for the flight are serviceable during the normal dispatch and pre-departure procedures. During the pre-flight check, typically at the departure gate, the MSS Satcom system will initiate self-checks once power becomes available from the aircraft power busses, following which it will complete the log-on sequence to the Inmarsat network.

As well as being fitted to commercial air transport aircraft, Inmarsat Satcom is also fitted to business jets and to government aircraft. Government aircraft fitted with Inmarsat Satcom include both military transport aircraft (e.g. C130, C17 and A400M) as well as aircraft used for transporting government officials. Both these groups of users typically use airports that are different to those used for international civil aviation transport flights. Consequently, this has a bearing on the list of airports that may require protection.

The Iris programme was initiated by the European Space Agency (ESA) with the aim of making aviation safer by developing new satellite based air-ground communication system for air traffic management (ATM). Iris requires enhancements to be made to the provision of the Inmarsat SB system, so that it can meet the safety, performance and cost requirements for ATM communication in the crowded European airspace. Iris is a part of a much broader push to modernise how air traffic control is managed in collaboration with the Single European Sky ATM Research (SESAR) joint undertaking launched in 2006 by Eurocontrol and the European Union. Following the completion of the Iris precursor evaluation stage that ran from October 2016 until June 2018, Iris is planned to commence the initial operational capability (IOC) stage shortly. Iris IOC comprises of upgrades to ground infrastructure serving the Inmarsat-4 and Alphasat satellites as well as the installation of Iris capable Satcom equipment on commercial flights operating within the European airspace and supporting air traffic control communication from late 2019. The primary concern for the existing installed base is the potential impact of interference on aircraft using MSS services for Automatic Dependent Surveillance –

Contract (ADS-C), Controller-Pilot Data Link Communications (CPDLC), as well critical operational data link services via the Aircraft Communications Addressing and Reporting System (ACARS) using MSS communications. This could potentially lead to disruption of departure/dispatch procedures and normal FANS operational procedures at the airport. Because these operations of primary concern generally include flight segments over oceanic or remote airspace with origin or destination points outside of the EU, the vast majority of such operations are conducted into and out of airports with port of entry facilities.

In the North Atlantic region (used for flights from Europe to/from North America), aircraft are required by ICAO from 29th of March 2018 to have FANS 1/A capability if they wish to use the preferred aircraft tracks and altitudes between 35,000ft and 39,000ft (see ICAO EUR NAT Doc 007). From 2020, this Satcom mandate will be expanded to all airspace above 29,000ft in the North Atlantic Region. According to these procedures, “If a flight experiences an equipment failure prior to departure which renders the aircraft non-DLM (Data Link Mandate) compliant, the flight should re-submit a flight plan so as to remain clear of the NAT DLM airspace". Aircraft without FANS 1/A capability would have to use tracks and altitudes, which might require additional fuel burn.

The MEL for one of Europe’s largest airlines states that loss of Satcom means that ADS-C and CPDLC (used for safety of flight communications (1525 to 1559 MHz) in regards to safe separation of aircraft) cannot be used which would not comply with the ICAO EUR NAT Doc 007 [6], meaning that aircraft flying the North Atlantic at a minimum would need to carry more fuel (or less cargo/passengers) since such an aircraft is not allowed to enter the airspace defined under the NAT data link mandate.

Thus, while the potential blocking of MSS is classified as a minor failure condition [7], and does not pose a direct threat to safety of flight in the vicinity of airports, it may result in the disruption of departures, delays and cost overruns for airlines.

Thus, there is an urgent need to take into due consideration the future introduction of mobile SDL below 1517 MHz and the need for suitable blocking characteristics. The minimum in-band blocking characteristic for future mobile earth stations receivers from a 5 MHz broadband signal interferer (LTE) operating below 1518 MHz shall be −30dBm above 1520 MHz, noting that the IMT block ends at 1517 MHz.

### 3.2 MARITIME

Safety of life at sea is regulated prominently by the International Maritime Organisation (IMO) through the International Convention for the Safety of Life at Sea (SOLAS), 1974 [8]. SOLAS Chapter IV defines the regulations for the Global Maritime Distress and Safety System (GMDSS). All passenger ships engaged in international voyages and cargo ships above 300 GT engaged on international voyages have to comply with the GMDSS[1]. Non-convention vessels participate in the GMDSS on a voluntary basis or under a national regulation.

In addition to GMDSS use, in accordance with other international conventions covering maritime issues, and for reasons of geographic coverage, availability and privacy, vessels make use of satellite services covering maritime issues including, security, pollution, environmental protection and monitoring, control and surveillance of fishing vessels. These applications are related to safety, security and communication in and near ports which are commonly carried by Satcom equipment that operates in the frequency band 1518-1559 MHz.

#### 3.2.1 Situation at sea

The SOLAS convention [8] divides the sea into areas A1, A2, A3 and A4, for GMDSS communications for which there are particular requirements on the installation of radio equipment such that ships are capable of complying with the GMDSS functional requirements of SOLAS Chapter IV, regulation 4, throughout all the

[1] The guidelines for the participation of non-SOLAS ships in the GMDSS are specified by IMO in MSC/Circ. 803 [9].

areas in which they will be sailing. The SOLAS compulsory carriage requirements ensure that ships are capable of:

- transmitting/receiving distress/alert/safety signals: performed by VHF, HF, MF, COSPAS/SARSAT EPIRB and Inmarsat terminals, noting that a minimum of two separate and independent means of communication (both installed and operational) are required for any area in which the vessel will be sailing;
- transmitting[2]/receiving Maritime Safety Information (MSI): performed by HF, NAVTEX stations or through Inmarsat services according to availability in the areas in which a vessel will be sailing.

SOLAS Chapter IV, regulation 7, defines the basic equipment to be installed on any ship subject to the Convention thus:

- VHF equipment for transmitting/receiving distress/alert/safety signals;
- Receiver of MSI from NAVTEX broadcast services (if a defined NAVTEX station service area covers a part or the whole path of the vessel);
- EPIRB satellite emergency position-indicating beacon operating through the COSPAS-SARSAT system.

Concerning the MSI, SOLAS IV, 7.5 stated that NAVTEX should be the prime source of MSI. Outside the NAVTEX service area Inmarsat Enhanced Group Calling System (EGC) should be used. Moreover, only in those cases where an EGC service is also not available may a ship be granted an exemption to use HF direct-printing telegraphy instead for the reception of MSI.

Concerning the capability to transmit or receive distress/alert/safety signals, SOLAS Chapter IV Regulations 8, 9, 10, 11 go on to provide the specific requirements for radio equipment on vessels when sailing through a given combination of Sea Area(s) A1[3], A2[4], A3[5] and A4[6]. For example, in area A1, SOLAS Chapter IV Regulation 8 applies, with its five subsection requirements, in addition to those of Regulation 7. It should be noted that:

- these subsections are coupled by an “or” which means that there are five solutions of radio-equipment to initiate a distress alert, including by use of Inmarsat terminals. The selection amongst those five solutions is up to the ship or flag -state to determine, not the coast- or port-state,
- two of these five possibilities are already listed under SOLAS Chapter IV Regulation 7 (mandatory for installation): 406 MHz COSPAS-SARSAT EPIRB and VHF radio using DSC[7];
- the declaration of Sea Areas A1 and A2 is a matter for those coast states responsible for their obligations under SOLAS; alternatively, coast states may declare their coastal areas to be part of Sea Area A3, in which case rescue authority support will primarily be through satellite communications. The declared sea areas are available in the GMDSS Master Plan;
- within the framework of SOLAS it is assumed that the L-Band Resources as well as HF are fully available within their defined service area. Appropriate means would need to be identified regarding how to inform member states and mariners if within a certain area the GMDSS L-Band service may not be available due to interference;
- there may be areas along the coastlines of CEPT countries where MSI through NAVTEX stations is either not available or not guaranteed.

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[2] SOLAS Ch. IV also mentions: It should be noted that ships may have a need for reception of certain maritime safety information while in port.

[3] Sea area A1 means an area within the radiotelephone coverage of at least one VHF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government.

[4] Sea area A2 means an area, excluding sea area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government.

[5] Sea area A3 means an area, excluding sea areas A1 and A2, within the coverage of an INMARSAT geostationary satellite in which continuous alerting is available.

[6] Sea area A4 means an area outside sea areas A1, A2 and A3.

[7] The other three options are MF radio using DSC, HF radio using DSC or an Inmarsat ship earth station.

Other issues related to this section are covered in Annex 1.

#### 3.2.2 Situation for inland waterways

In the CEPT countries, the regulation within inland waterways indicates that for the Inland locations there is:

- a required usage of VHF communications for countries having signed the Arrangement RAINWAT [10];
- a required usage of radio communications compliant with AIS system for countries in the European Union based on the Directive 2005/44/EC [11], noting that AIS system protocol is only compatible with VHF maritime mobile band, as indicated in RAINWAT arrangement (Chapter 1, Article 1, Section C).

This means that for some countries in EU and for countries having signed the RAINWAT arrangement, VHF must be used for inland locations where the SOLAS convention is not defined. Hence administrations will need to consider whether or not there is a need to provide additional protection to MSS terminals in inland waterways in those countries.

**Other arrangements may apply for other countries that are not party to the RAINWAT Arrangement** or in the EU and individual administrations could decide at national level to provide protection to L-band MSS at locations that include some inland waterways.

#### 3.2.3 Testing at seaports

For SOLAS vessels, demonstration of the functioning of the Satcom equipment happens during Port State Control (PSC) inspections of GMDSS and before leaving the harbour (by the crew). IMO Resolution A.1104(29) [12] provides guidance on how to check the correct functioning of maritime radio equipment during a survey. It is stated that it can be done by “checking for correct operation by inspection of recent hard copy or by test call”. However, it is recognised that testing of terminal operation in port is often carried out for the sake of simplicity, and may be essential where a vessel has been several days in port or under required maintenance.

In case of interference, for a survey demonstrating that the equipment has been able to work properly “by inspection of recent hard copy” is sufficient to consider the proper working. If a recent hard copy is not available, “a test call” is the only method of showing compliance.

According to SOLAS/IV, 15.8, “While all reasonable steps shall be taken to maintain the equipment in efficient working order to ensure compliance with all the functional requirements specified in regulation 4, malfunction of the equipment for providing the general radiocommunications required by regulation 4.8 shall not be considered as making a ship unseaworthy or as a reason for delaying the ship in ports where repair facilities are not readily available, provided the ship is capable of performing all distress and safety functions” [8]. Hence failure of a test of general communications should be followed by a test of distress and safety functions. The failure of GMDSS equipment on the other hand could make a ship unseaworthy.

For non-convention vessels, test before departure requirements are in accordance with flag-state regulation.

The survey, maintenance and repair requirements related to GMDSS and other communications, for example LRIT and SSAS, are also carried out while in port.

# 4 TIMING AND STEPS FOR THE INTRODUCTION OF MFCN IN L-BAND AND PROTECTION OF MES IN ADJACENT BANDS

## 4.1 TIMING OF AVAILABILITY OF SPECTRUM AND AUTHORISATION FOR SDL

ECC Decision (17)06 [2] designates the bands 1427-1452 MHz and 1492-1518 MHz to MFCN SDL, subject to national requirements and market demand. This Decision entered into force on 17 November 2017.

According to the EU Commission Implementing Decision (EU) 2015/750 [3], all or some of the frequencies in the ranges 1427-1452 MHz and 1492-1517 MHz shall be designated and made available for wireless broadband by 1 October 2018. This mandatory framework for EU Member States leaves some flexibility to reorganise the bands 1427-1452 MHz and 1492-1517 MHz in order to make them available for mobile SDL (up to 1 January 2023, and longer if no national demand has been identified for wireless broadband electronic communications services).

Some CEPT administrations are actively engaged in a complex refarming process in order to make available 90 MHz for mobile SDL.

## 4.2 TIMING FOR AVAILABILITY OF NEW MES EQUIPMENT

Given the time required to set and agree standards, build and deploy new terminals in the maritime and aeronautical markets, it is expected that proportionate measures imposed by administrations required to protect aeronautical terminals at airports and maritime terminals at seaports, where and if required, will be on a phased approach; with the initial measures - Phase 1, to protect currently operating terminals which are more sensitive to blocking, followed by Phase 2 which would involve more relaxed constraints, where required, on IMT BSs as the protection measures will be based on more resilient terminals. Phase 1 will be time limited and to be replaced by Phase 2. Phase 2 will be based on future, more resilient terminals meeting a blocking resilience of -30 dBm at the input of the MES receiver. Future terminals will be designed to meet the relevant standards applicable for aeronautical and maritime terminals.

Development of new equipment that will meet the new blocking requirements will require:

- Revision of standards related to aeronautical equipment: The process of updating ARINC characteristics 741 [13], 761 [14], and 781 [15] is under way, with an expected completion date of March 2019. A proposal to update the MOPS (RTCA DO-210D [16], DO262C [17] and EUROCAE ED-243 [18]) and MASPS (RTCA DO-343 [19], EUROCAE ED-242 [20]) has been submitted and accepted as an agenda item in September 2018. If accepted, the necessary updates to these standards will be performed throughout 2019;
- Revision of standards related to maritime equipment, noting that this might require the availability of an ITU-R Recommendation as a basis. The IEC standards for receiver performance as well as the ETSI Standards refer to the satellite operator's equipment standards. A new mask defined by ITU-R through a recommendation might facilitate the development of a new receiver blocking requirement applicable to new terminals worldwide.

For aeronautical terminals, availability of equipment could be expected within one or two years after publication of the new standards.

For some maritime services, such as Fleet Safety, new equipment may be expected to be available approximately 2020. Some of the well-established services such as Inmarsat C, are popular but new terminal designs are rare. Hence, new terminals may not be routinely developed by manufacturers as a consequence of the introduction of new equipment standards alone and may consider the need to ensure that new terminals that meet the new blocking requirement are developed.

### 4.3 LIFETIME OF EQUIPMENT ON BOARD VESSELS AND AIRCRAFT

The useful economic life of a commercial air transport aircraft is approximately 20-30 years (aircraft are normally retired from service with most of the same equipment and systems they were delivered with). Aircraft retrofits including satellite mobile communications terminals are possible but rare due to economic reasons.

Any changes to aeronautical Satcom requires updates to the performance standards (see section 4.2), procedures, regulations and guidelines which govern air transport.

New equipment must be developed to the new standards and certified as safe for use by a competent authority. Once equipment has been certified, it has to be incorporated into the production of new aircraft for line-fit delivery, mandated for installation and made available to the aftermarket. For retrofit installations, a supplementary type certificate (STC) must be obtained from EASA/FAA for each type and variant of aircraft.

There are currently no certified aeronautical Satcom terminals that meet the blocking requirement of −30 dBm for MFCN at 1512-1517 MHz.

For maritime terminals, the useful economic life of a commercial vessel is approximately 20-30 years, where vessels are scrapped from service with most of the initial equipment they were delivered with. As shown in Table 7, as of 2018, 15% vessels equipped with Inmarsat C use terminals older than 20 years. The procedure for replacement of terminals requires new standards. Any requirement for replacement is the responsibility of the IMO (via the member states), and in addition the EU for those services required by them. There is currently no mechanism to enforce the upgrade/replacement of Marine equipment which met the technical standards in force when originally fitted and it would take a number of years to put this mechanism in place.

### 4.4 POTENTIAL TO ACCELERATE RETROFIT

It has been concluded that blocking of MES due to MFCN below 1518 MHz may cause disruption of services, as well as departures, delays and cost overruns for shipping companies and airlines (see section 3.1 and 3.2). To this end it is important that resilient equipment, based on updated standards, is available on the market in order to enable shipping companies or airlines to avoid any potential interruption of their business due to MFCN below 1518 MHz, by retrofitting their vessels or aircrafts with new equipment.

At the same time the service providers also have business incentives in ensuring that the service may continue with the same service level as currently, when MFCN is brought into use below 1518 MHz - thus they may consider either to aid affected customers amongst airlines and shipping companies in the retrofit of upgraded MES equipment or to trigger migration to usage of compatible MES equipment.

An example of an implementation pipeline for the retrofit of equipment on aircraft is Iris (as a part of the SESAR project) which is designed to improve air traffic management over continental and transoceanic airspace. In the context of Iris, new terminals for aircraft should meet the new standards and new blocking requirements. There is currently no requirement for Iris equipage. A requirement for installation of Iris compatible and resilient satellite communication terminals on aircraft would potentially solve several problems, one being the need to address capacity constraints with VHF data link (VDLm2), and the other being to minimise the constraints on deployment of SDL or reduce the risk of interference to Satcom.

If a requirement for Iris equipage is put forward, the implementation timeline would look like illustrated in Figure 2 below.

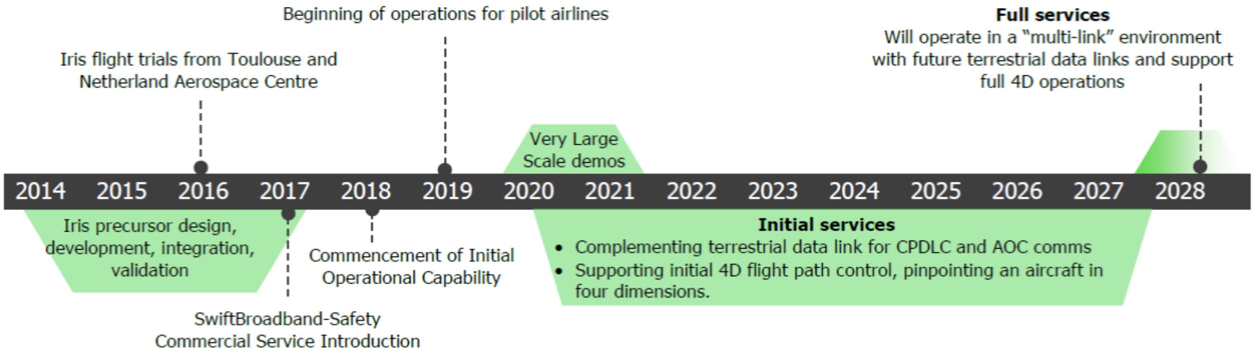


**Figure 2: Implementation pipeline in the context of Iris**

## 4.5 TIMING FOR PROTECTION OF MES TERMINALS

To protect maritime and aeronautical communications, two phases are proposed with a transition period. For phase 1, the PFD limits are based on either existing regulation outside CEPT or the measured blocking performance of the maritime and aeronautical terminals. Phase 2 may provide a permanent PFD limit for IMT coverage in the same locations as phase 1, based on the −30 dBm blocking requirement (requested by CEPT for land mobile earth stations in 2017) for the block 1512-1517 MHz.

Recommending timing for the transition from phase 1 to phase 2 will facilitate satellite operators preparing retrofit operations for terminals/users requiring protection. Timing for closure of services is based on Inmarsat's public service obligations, which is typically 5-7 years[8]. Timing for the replacement of Satcom equipment is expected to be in a similar range but it should be noted that the ending of the transition period relies on the availability of suitable terminals which allow their widespread deployment noting that some equipment already meets the blocking requirements (See Table 6).

CEPT will recommend timing for the transition from phase 1 to phase 2 which may differ for maritime, aeronautical MES terminals. CEPT is making the assumption that MES Terminals operating under IRIS project are not subject to phase 1.

CEPT will inform ICAO/IATA and IMO so that they can take the appropriate steps with no delay in order to reduce the duration of the phase one to an acceptable/reasonable timeframe; and with the airlines and their trade bodies (e.g. Airlines for Europe ("A4E")) to establish a realistic time schedule for the adoption of new aeronautical terminals.

[8] See documents [21] and [22] describing phasing-out of Inmarsat A & B in 5 & 7 years respectively

# 5 PROPORTIONATE MEASURES TO ADDRESS THE POTENTIAL BLOCKING OF MES TERMINALS

This section presents proportionate solutions that CEPT members could implement to address potential blocking of L-band MSS receivers in specific areas or locations. Each national administration will decide which areas or locations require protection, how to do so, e.g. by using options outlined in this section if suitable to their national circumstances, and the timing related to the application of the different protection measures.

## 5.1 PFD LIMITS FOR MFCN BASE STATIONS

In order to ensure protection of maritime and aeronautical terminals at selected seaports and airports respectively, one option is to apply a protection measure based on PFD limits for MFCN BS and this methodology is described in this section. Two phases are proposed with a transition period as described in section 4.5

To minimise any potential blocking of next generation MES receivers, CEPT concluded in ECC Report 263 that the minimum out of-band blocking characteristic for land mobile earth stations receivers from a 5 MHz broadband signal interferer (LTE) operating below 1518 MHz shall be −30 dBm for the band above 1520 MHz, noting that the IMT block ends at 1517 MHz. The same blocking level value will be used for next generation maritime and aeronautical MESs. The value of the PFD limit for Phase 2 could be derived based on the −30 dBm blocking requirement above 1520 MHz.

The value of the PFD limit for Phase 1 (i.e. during the transition period) could be derived by considering a more stringent (lower) value of blocking than −30 dBm. This value could be based on either:

- existing regulation outside CEPT: FCC document FCC 05-30 [23], paragraph 63 based on CDMA-2000 instead of OFDM considered −52 dBm for 1-2 MHz frequency separation; −50 dBm would provide better protection for a larger frequency separation for the case of CEPT. It should be noted that Inmarsat C and Inmarsat aeronautical terminals are not included in this test; or
- blocking measurements performed by some manufacturers (see Section 2.1 for aeronautical receivers and Section 2.2 for maritime receivers).

When selecting a MES blocking requirement, it is possible to derive the maximum PFD limit using the following formula:

$$pfd_{max} = I_{max} - Ae_{iso} - G_{MES}$$

Where:

- $pfd_{max} = Maximum\ Power\ Flux\ Density$ ;
- $I_{max} = Maximum\ Interferer\ level\ (i.e. blocking\ requirement)$;
- $Ae_{iso} = Effective\ Apperture\ area\ of\ an\ Isotropic\ Antenna\ \left(= \frac{\lambda^2}{4\pi}\right)$;
- $G_{MES} = Gain\ of\ MES\ in\ the\ direction\ of\ the\ BS.$

Examples of PFD values based on this calculation method are included in ANNEX 2

The areas in which maritime earth stations and aeronautical earth stations are protected through the application of these PFD limits, as well as the methods applied to achieve these limits, will be defined by administrations.

## 5.2 COORDINATION THRESHOLDS

In order to ensure an efficient usage of the spectrum, and similarly to application of a cross-border coordination procedure, the PFD limits described in section 5.1 could be treated as PFD coordination thresholds for base stations at the boundary where MSS terminals may operate and may need protection.

Hence indoor installations at the harbour/airport could then be allowed as long as the PFD value outside the building is lower than the coordination threshold.

The reference height for PFD threshold at the "fence" should be calculated having in mind the height of a vessel/plane above ground level.

As long as PFD at the "fence" is kept under the co-ordination threshold, usage of the 1492-1517 MHz should not have any other restrictions.

## 5.3 GUIDANCE TO ADMINISTRATIONS REGARDING THE LOCATIONS (AIRPORTS/SEAPORTS) NECESSARY TO BE PROTECTED, POSSIBLY IN CONJUNCTION WITH NATIONAL AUTHORITIES FOR AVIATION AND MARITIME

From the maritime Satcom perspective, proportionate protection measures are to be provided in some ports and other areas where protection might be provided, which national administrations may need to identify in consultation with their maritime authorities. National maritime authorities in which jurisdiction MFCN SDL is or will be implemented are encouraged to inform the concerned parties (i.e. IMO, the crew of ships, the Port State Control officers) of any risk of interference of MES terminals due potential blocking at the sea ports and other areas in order to provide appropriate advice which course of actions is appropriate (e.g. for maritime favouring during inspection recent hard copy in case there is a suspicion of interference).

From the aeronautical perspective, proportionate protection measures are to be provided in airports with transoceanic flights departures since pilots have to test Satcom before departure. The result of the test is not, strictly speaking, a safety issue, but, in case of interference, flights would not be allowed which would cause significant disruption in flights traffic. Further consideration may be needed in relation with the Iris programme from Eurocontrol which would use Satcom for European flights in order to alleviate VHF congestion.

# 6 CONCLUSIONS

This ECC Report has considered proportionate solutions that CEPT members could implement to address potential blocking of L-band MSS receivers in specific areas or locations. Each national administration exercising its sovereign rights in the field of frequency management will decide which areas or locations require protection and how to do so, based on the safety of life and security risks or other specific needs identified, e.g. by using options outlined in section 5 of this Report if suitable to their national circumstances.

This Report has identified certain maritime and aeronautical applications that administrations may wish to take into account in determining airports and seaports for application of the proportionate measures. Regarding maritime operations, administrations may choose to provide protection based on GMDSS services, which operate in the band 1530-1544 MHz, noting that this may also protect other maritime MSS operations outside this band if used at the same seaports. Regarding aeronautical operations, administrations may choose to provide protection based on AMS(R)S services, which operate in the band 1525-1559 MHz, noting that this may also protect other aeronautical MSS operations outside this band if used at the same airports. If administrations also provide protection of MSS applications which are operating outside the GMDSS/AMS(R)S bands, this may require protection measures at additional seaports/airports, but the pfd values recommended in this Report remain unchanged.

## ANNEX 1: OTHER MARITIME ISSUES IDENTIFIED

During the drafting of this Report, some issues which fell outside the scope of the work item given by ECC were identified, but may be relevant for the identification of maritime operational systems. This annex provides a short overview of these issues.

- The term “port” is not defined by ITU and it has not been possible to find an internationally agreed definition. In this Report, the term port here is used to describe any location at which a vessel may be moored. A port is generally a place where cargo may be loaded or unloaded;
- A seaport in some definitions means a port on the sea; in other definitions it also includes ports accessible to the sea by inland waters such as rivers, lakes or canals. Many ports are situated on inland waterways; examples include Hamburg, Rotterdam and Antwerp;
- Sea areas around CEPT: Several areas of the CEPT coast is Sea Area A3 where satellite services are necessary (The high availability of GMDSS satellite services is necessary because vessels may have a very limited time to send a distress alert);
- Schedule and coverage of Maritime Safety Information: International warnings and weather forecasts are transmitted according to a published routine at intervals, e.g. 4 hours in the UK, and apply to a specific geographical area. NAVTEX messages apply to a defined geographical area within the propagation area of the associated terrestrial transmitter and adjacent to the coast; scheduled EGC SafetyNet NAV/MET transmissions cover larger areas than NAVTEX areas and are sent twice a day[9]. Where EGC is blocked, vessels may quickly transit beyond the limits of the NAVTEX area (a cargo vessel will typically cover 100nm in 6 hours, cruise ships typically 140nm);
- The GMDSS Sea Areas defined in SOLAS are for the application of carriage requirements to SOLAS vessels, not for defining usefulness of equipment. LRIT which relies on satellite communications is primarily a security system, but used by Rescue Coordination Centres for situational awareness during incidents;
- The focus of this report are vessels to which Chapter IV of the SOLAS Convention apply. Other vessels, the great majority, have to comply with their flag-state regulations which may include use of MES for longer range communications (beyond line of sight) because of its simplicity and wider application than terrestrial communication equipment described in SOLAS regulations;
- Safe Havens: Vessels (including SOLAS convention, regulated and unregulated vessels) may use safe havens for protection from storms, etc. for extended periods of time. These geographical areas could be considered for protection at national level (within 1530-1544 MHz band);
- Other non-safety communications outside GMDSS;
  - General communications: Vessels may use satellite services for general purpose data communications because terrestrial maritime data services are unreliable, limited in capacity, geographically limited, or complex to operate effectively for an international vessel;
  - IMO conventions covering maritime issues including, security, pollution and environmental protection, prevention of unnecessary delays in maritime traffic, and co-operation between Governments require communication of information for implementation;
  - Future needs: Maritime developments such as remotely controlled shipping are likely to need high capacity and high availability communications to achieve greater efficiencies and may provide the stimulus for installation of new communications equipment;
  - Long Range Identification and Tracking (LRIT) is mandatory under SOLAS V/19-1 [8] and performed by satellite communications. IMO guidance [25] is that only the vessel flag state can issue instructions for switching off tracking transmissions, normally only when the vessel is out of service for an extended period and currently uses MSS systems in the L-band;
  - Ship Security Alerting System (SSAS) is a covert system for reporting to a competent authority that the vessel security has been compromised. It is a mandatory requirement for convention vessels on international voyages and currently uses MSS systems in the L-band. This application could be provided by other communication means (HF, MF and VHF), where available;

[9] International SafetyNET users handbook [22] Table 1 provides SafetyNet transmission timings

- Vessel Monitoring Systems (VMS) equipment is type approved by the flag state and operates via Satcom. The exact reporting requirements are determined by the flag-state rules, from before getting underway when leaving port until tied up again in port on return, and in some cases, continuously while in port. Some national maritime authorities mandate the use of satellite-systems operating in the band 1530-1544 MHz.

# ANNEX 2: EXAMPLES OF PFD LIMITS

The PFD limits calculated in this annex are based on an assumed MES antenna gain ($G_{MES}$) of 3 dBi.

## A2.1 EXAMPLES OF PFD LIMITS BASED ON REGULATION OUTSIDE CEPT

The PFD limits in this section are based on measurements of MSS terminals conducted by FCC. FCC document FCC 05-30 [23], paragraph 63 based on CDMA-2000 instead of OFDM considered −52 dBm for 1-2 MHz frequency separation; −50 dBm would provide better protection for a larger frequency separation for the case of CEPT. It should be noted that Inmarsat C and Inmarsat aeronautical terminals are not included in this test.

**Table 10: PFD limits on MFCN BS transmitting a single channel**

| Phase | Phase 1 | | | Phase 2 | | |
|---|---|---|---|---|---|---|
| | PFD limit for BS emissions in the band 1492-1502 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1502-1512 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1512-1517 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1492-1502 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1502-1512 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1512-1517 MHz (dBm/m$^2$) |
| Ports and inland waterways | −12.9 | −12.9 | −27.9 | No limit required | 2.1 | -7.9 |
| Airports | −12.9 | -12.9 | −27.9 | No limit required | 2.1 | -7.9 |

**Table 11: PFD limits on MFCN BS transmitting multiple channels**

| Phase | Phase 1 | | | Phase 2 | | |
|---|---|---|---|---|---|---|
| | PFD limit for BS emissions in the band 1492-1502 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1502-1512 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1512-1517 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1492-1502 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1502-1512 MHz (dBm/m$^2$) | PFD limit for BS emissions in the band 1512-1517 MHz (dBm/m$^2$) |
| Ports and inland waterways | -12.9 | -12.9 | -27.9 | No limit required | 2.1 | -7.9 |
| Airports | -12.9 | -12.9 | -27.9 | No limit required | 2.1 | -7.9 |

## A2.2 EXAMPLES OF PFD LIMITS BASED ON BLOCKING MEASUREMENTS PERFORMED BY SOME MANUFACTURERS

For phase 1, the PFD limits in this section are based on the blocking measurements of the most susceptible terminal performed by some Satcom manufacturers which were presented in sections 2.1 and 2.2. For phase 2, the PFD limits in table 12 are based on −20 dBm and −30 dBm blocking levels resulting from the band

1502-1512 MHz and the band 1512-1517 MHz respectively; and the PFD limits in table 13 are based on −23 dBm and −33 dBm blocking levels resulting from the band 1492-1512 MHz and the band 1512-1517 MHz respectively.

**Table 12: PFD limits on MFCN BS transmitting a single channel**

| Phase | Phase 1 | | | Phase 2 | | |
|---|---|---|---|---|---|---|
| | PFD limit for BS emissions in the band 1492-1502 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1502-1512 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1512-1517 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1492-1502 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1502-1512 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1512-1517 MHz ($dBW/m^2$) |
| Ports and waterways | -60.9 | -75.9 | -83.9 | No limit required | -27.9 | -37.9 |
| Airports | -32.9 | -42.9 | -58.2 | No limit required | -27.9 | -37.9 |

**Table 13: PFD limits on MFCN BS transmitting multiple channels**

| Phase | Phase 1 | | Phase 2 | |
|---|---|---|---|---|
| | PFD limit for BS emissions in the band 1492-1512 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1512-1517 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1492-1512 MHz ($dBW/m^2$) | PFD limit for BS emissions in the band 1512-1517 MHz ($dBW/ m^2$) |
| Ports and waterways | -74.9 | -85.9 | -30.9 | -40.9 |
| Airports | -53.5 | -63.4 | -30.9 | -40.9 |

## ANNEX 3: LIST OF REFERENCES


[1] ECC Report 263: "Adjacent band compatibility studies between IMT operating in the frequency band 1492-1518 MHz and the MSS operating in the frequency band 1518-1525 MHz"

[2] ECC Decision (17)06: "The harmonised use of the frequency bands 1427-1452 MHz and 1492-1518 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL)", November 2017

[3] EC Decision (EU) 2015/750 "on the harmonisation of the 1427-1517 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Union"

[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] Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council

[6] ICAO EUR NAT Doc 007 V2018-1: "North Atlantic Operations and Airspace Manual"

[7] FAA TSO-C132: "Geosynchronous Orbit Aeronautical Mobile-Satellite Services Aircraft Earth Station Equipment", March 2004

[8] International Convention for the Safety of Life at Sea (SOLAS), 1974

[9] IMO MSC/Circ. 803: "Participation of non-SOLAS ships in the Global Maritime Distress and Safety System (GMDSS)", June 1997

[10] Regional Arrangement on the Radiocommunication Service for Inland Waterways, revised October 2016

[11] DIRECTIVE 2005/44/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 September 2005 on harmonised river information services (RIS) on inland waterways in the Community

[12] IMO Resolution A.1104(29): "Survey guidelines under the Harmonized System Of Survey And Certification (HSSC)", December 2015

[13] ARINC 741: "Aviation satellite communications system (Satcom) part: 2 system design and equipment functional description", June 1994

[14] ARINC 761: "Second generation aviation satellite communication system, aircraft installation provisions", June 2012

[15] ARINC 781: "Mark 3 aviation satellite communication systems", August 2017

[16] RTCA DO-210D: "Minimum Operational Performance Standards for Geosynchronous orbit Aeronautical Mobile Satellite Services (AMSS) Avionics", March 2015

[17] RTCA DO-262: "Minimum Operational Performance Standards for Avionics Supporting Next Generation Satellite Systems (NGSS) ", May 2017

[18] EUROCAE ED-243: "Minimum Operational Performance Standards for Avionics Supporting Next Generation Satellite Systems (NGSS)", April 2017

[19] RTCA DO-343: "Minimum Aviation System Performance Standard For AMS(R)S Data and Voice Communications Supporting Required Communications Performance (RCP) And Required Surveillance Performance (RSP)", May 2017

[20] EUROCAE ED-242: "MASPS for AMS(R)S Data and Voice Communications Supporting Required Communications Performance (RCP) and Required Surveillance Performance (RSP)", April 2017

[21] IMO COMSAR 14/INF.6: "Satellite Services (Inmarsat and Cospas-Sarsat); Future cessation of Inmarsat “B” service - Note by the International Mobile Satellite Organization (IMSO)", December 2009

[22] IMO NCSR 1/18/1: "Consideration of Developments in Inmarsat and Cospas-Sarsat; Inmarsat B Services - Submitted by the International Mobile Satellite Organization (IMSO)”, March 2014

[23] FCC 05-30: "Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands - Memorandum Opinion and Order and Second Order on Reconsideration", February 2005

[24] IHO International SafetyNET Manual 2018 Edition

[25] IMO MSC.1/Circ.1295: "Guidance in relation to Certain Types of Ships which are Required to Transmit LRIT Information on Exemptions and Equivalents and on Certain Operational Matters", December 2008

[26] ECC Decision (13)03: “The harmonised use of the frequency band 1452-1492 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL)”, amended 2018