CEPT ECC
Electronic Communications Committee

ECC Recommendation (18)01

Radio frequency channel/block arrangements for Fixed Service systems operating in the bands 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz

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INTRODUCTION

The primary use of Fixed Service (FS) is currently for mobile backhaul/fronthaul applications. Due to continuous evolution of mobile networks, new applications and deployment scenarios will emerge in the future demanding an ever increasing payload capacity.

The millimetre wave spectrum in the range from 130 to 174.8 GHz attracts increased interest of service providers and systems designers because of the large spectrum availability for FS scenarios.

The use of high efficiency modulation formats, adaptive modulation and MIMO[1] techniques, possibly coupled into BCA[2] links, would also permit large payload increase; information on adaptive modulation and MIMO technique may be found in ECC Report 198 [6] and ECC Report 258 [7], respectively. Therefore, radio links operating in the 130-174.8 GHz bands can fulfil applications supporting multi Gbit/s capacity per link in an environment with multiple operators in the same geographical area.

According to ITU-R Recommendation P.676 [8], the atmospheric gas attenuation is still less than about 2 dB/km below 164 GHz and rises above 3 dB/km only at the 174 GHz top edge of the band. According to the ITU-R Recommendation P.838 [1], the rain attenuation above about 80 GHz becomes practically constant, it is therefore comparable to that experienced in lower bands, e.g. in the 71 GHz to 86 GHz band considered in ECC/REC(05)07 [2].

This makes the bands in 130-174.8 suitable for very high capacity on short range links.

The choice of the appropriate assignment method and licensing regime remains a decision for national administrations, based on several technical and non-technical factors.

Modern Point-to-Point (PP) system technology permits various options of bidirectional links covering both symmetrical/asymmetrical traffic (see ECC Report 211 [9]) with TDD or FDD duplexing (the latter realised with conventional duplex filter or other techniques such as Flexible FDD (fFDD[3]) or Full Duplex (FD[4]).

However, conventional link by link planning/coordination procedure might be very challenging due to the expected dense urban deployment, mostly at street lamp posts level; interference due to reflection and diffraction effects cannot be treated as in conventional Line of Sight (LoS) only situation. Nevertheless, multiple services and applications can be implemented, with simplified coordination mechanisms, still ensuring, in average, highly efficient re-use of the frequency band.

Such simplified coordination mechanism is understood as where the links coordination, traditionally under the responsibility of the administration, is still required but would be performed by the license holders (i.e. operators); this process could be further simplified where administrations might subdivide the available band in blocks to be separately used by major operators that could be required only to communicate the technical data of the deployed links (for e.g. maintain national PP data base and fee calculation). The deployment within blocks of frequency, when they are permanently assigned to an operator, might also permit mixed use of PP and/or Point-to-Multipoint (PMP) systems.

On this subject, ECC Report 80 [3] describes a “light licensing regime” summarised as: *“Light licensing regime, where the position and characteristics of the stations are recorded on a database on a first-come first-served basis, with responsibility for subsequent users to ensure the compatibility with previously notified stations”*.

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1 Multiple Input Multiple Output (MIMO), a spatial frequency reuse technique.

2 Band and Carrier Aggregation (BCA) system, operation on the same link of two different band equipment; e.g. 18 GHz and 80 GHz link, the first giving high availability to the priority traffic portion and the latter offering larger capacity with less availability (i.e. for best effort traffic).

3 While in conventional FDD systems TX/RX isolation is obtained through RF duplex filter, in flexible frequency division duplex (fFDD) systems the isolation could be obtained through separate TX/RX antennas and/or digital cancellation (similar to XPIC technology); this enhances the TX/RX isolation capability and permits narrower duplex spacing.

4 Full Duplex (FD) systems use the same channel for go/return (as TDD systems), but for 100% of the time; they should provide necessary TX/RX isolation through separate TX and RX antennas and digital cancellation, rather than through duplex filter as in conventional FDD systems.

The use of the 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz bands provides an inviting opportunity to further cope with the future market demands for increasingly very high bandwidth access, in particular for Internet-based applications and backhaul/fronthaul for next generation mobile networks. Fixed radio links may be deployed much quicker and in certain cases (e.g. when radio stations are deployed at street level on urban utilities infrastructures) are more cost efficient than the wired networks, and as such these bands provide sufficient bandwidth for terrestrial fixed links to compete or complement the fibre optic-based access networks.

In the proposed scenario using the 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz bands for Fixed Services, the availability objectives of 99.99% or higher with the average European rain rates are satisfied for very high capacity links up to about 1 km hop lengths (Line of Sight conditions). Longer hops may be implemented in the less rainy areas or with reduced availability objectives (e.g. in Band and Carrier Aggregation (BCA) links). These systems would allow a rapid and effective deployment for mobile backhaul/fronthaul and very high capacity broadband in areas where fibre optic cables are not available or are not cost-effective.

A possible indoor use of these bands would be free from rain attenuation and high availability up to 99.999% is possible; therefore, the radio links are considered an alternative to fibre cable connecting large servers in big data centres. Such use would have to be considered through appropriate authorisation at the national level.

The main features of operating fixed radio systems in this part of the spectrum may be summed up as follows:

- availability of very wide bandwidths, allowing for the low cost of traffic in multi service provider operation area;
- feasibility of deploying radio links is much easier in comparison to alternative wire-bound solutions;
- ability to ensure high security because of low possibility of interference/capture of signals.

The use of the spectrum between 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz is a viable solution for fixed links to achieve the above objectives.

The ECC Report 124 [4] that addresses the compatibility between the FS and passive service in the bands 71-76 GHz and 81-86 GHz and adjacent bands where Radio Regulations footnote 5.340 applies is still applicable for the compatibility in the adjacent bands 148.5-151.5 GHz, 164-167 GHz, allocated to passive services in between these FS bands.

ECC RECOMMENDATION OF 18(01) ON RADIO FREQUENCY CHANNEL/BLOCK ARRANGEMENTS FOR FIXED SERVICE SYSTEMS OPERATING IN THE BANDS 130-134 GHZ, 141-148.5 GHZ, 151.5-164 GHZ AND 167-174.8 GHZ

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that there is need for fixed links for backhauling of mobile cells and other multi-Gbit/s data links in urban environment;

b) that ITU Radio Regulations (RR) [11] and the ECA Table [10] allocate the bands 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz on a primary basis to Fixed Service as well as other co-primary services;

c) that ITU RR No. **5.340** prohibits all emissions, inter alia, in the bands 148.5-151.5 GHz, 164-167 GHz, and therefore care should be taken to limit the out-of-band emissions from FS operating in the bands 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz into those adjacent bands;

d) that ITU RR No.**5.149** applies to the frequency range 130-134 GHz, 136-148.5 GHz, 151.5-158.5 GHz, 168.59-168.93 GHz, 171.11-171.45 GHz, 172.31-172.65 GHz and 173.52-173.85 GHz and urges administrations to take all practicable steps to protect the Radio Astronomy Service (RAS) from harmful interference;

e) that the ECC Report 124 [4] addresses methodology and emission limits, where appropriate, for the compatibility between the FS in the bands 71-76 GHz and 81-86 GHz and Earth Exploration-Satellite Service (EESS) stations operating in the bands 86-92 GHz and RAS stations operating in the bands 76-77.5 GHz and 79-92 GHz; and that ECC Report 124 may still be conservatively applicable for the compatibility between FS operating in the bands identified in considering b) and EESS operating in bands identified by considering c) and RAS stations operating in the bands identified in considering d);

f) that the propagation characteristics of the 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz are ideally suited for use of short range FS links with various occupied bandwidths in very high density networks for a range of applications including backhaul/fronthaul for next generation mobile networks;

g) that ECC/REC/(01)05 [5] provides information for planning of PP Fixed Service systems in conventional full Line of Sight (LoS) deployment;

h) that modern Point-to-Point (PP) system technologies permit to use radiofrequency channels either unpaired (TDD or FD[4]) or paired (conventional FDD or fFDD[3]) or aggregated into blocks in use to different users;

i) that longer links are possible to enhance capacity of conventional lower band links in BCA[2] systems;

j) that most of the links in these bands are expected to be deployed on street level (e.g. light poles, public transport stalls, etc.);

k) that alternative to conventional coordination, a form of self-coordination of links within block(s) of channels assigned to major users, could maintain spectrum efficiency and availability for FS avoiding harmful interference among the users;

l) that as an alternative to conventional coordination, a simple form of coordination, similar to that described by ECC Report 80 [3] as "light licensing", could maintain spectrum efficiency and availability for FS avoiding harmful interference among the users;

m) that, as the propagation loss difference in the bands 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz is within the range of 1 dB for the hop lengths of up to 1 km, this also suggests the possibility of using these bands together for FDD links with large duplex separation, if necessary;

n) that narrower duplex separation is also possible with modern digital cancellation techniques and, when considering the very short wavelength in this bands, small separate transmitter/receiver (TX/RX) antenna integral to the same equipment is feasible.

recommends

1. that the use of FS in the 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz bands may be intended for Point-to-Point (PP) and Point-to-Multipoint (PMP) systems provided that suitable deployment methods (e.g. within predefined blocks) are considered;

2. that operating frequencies for PP links in these bands be assigned or recorded on a link-by-link basis or within block assignment provided that inter block compatibility is ensured;

3. that administrations wishing to use the whole or parts of the frequency bands 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz for FS links and preferring to implement channel arrangement should consider the basic 250 MHz channel arrangements given in ANNEX 1:;

4. that administrations may consider flexible aggregation of those 250 MHz basic channels for composing wider channels, while taking into account appropriate spectrum efficiency;

5. that administrations wishing to use block-based assignment should derive blocks by channel aggregation in line with the paired or unpaired examples shown in ANNEX 2: , and used accordingly; blocks should be multiple of 250 MHz and their use should permit any suitable channel size and duplex method as shown in the examples given in ANNEX 2:;

6. that administrations wishing to assign traditional FDD duplex channels or blocks, may use the bands 130-134 GHz, 141-148.5 GHz, 151.5-164 GHz and 167-174.8 GHz as paired bands with suitable spacing > 15 GHz as shown in the example of ANNEX 2: and ANNEX 3: (Figure 5:, Figure 6: and Figure 7:);

7. that administrations who wish to implement a self-coordination mechanism similar to “light licensing” may refer to the example provided in ANNEX 4:;

8. that in order to protect the Earth Exploration-Satellite Service (EESS) operations in the bands 148.5-151.5 GHz, 164-167 GHz, the unwanted emissions at the antenna port of any FS station in those bands should respect the mask provided in ANNEX 5:.”

Note:

Please check the Office documentation database http://www.ecodocdb.dk for the up to date position on the implementation of this and other ECC Recommendations.

ANNEX 1: RADIO-FREQUENCY CHANNEL ARRANGEMENTS IN THE BAND 130-174.8 GHZ

A1.1 BASIC CHANNEL RASTER

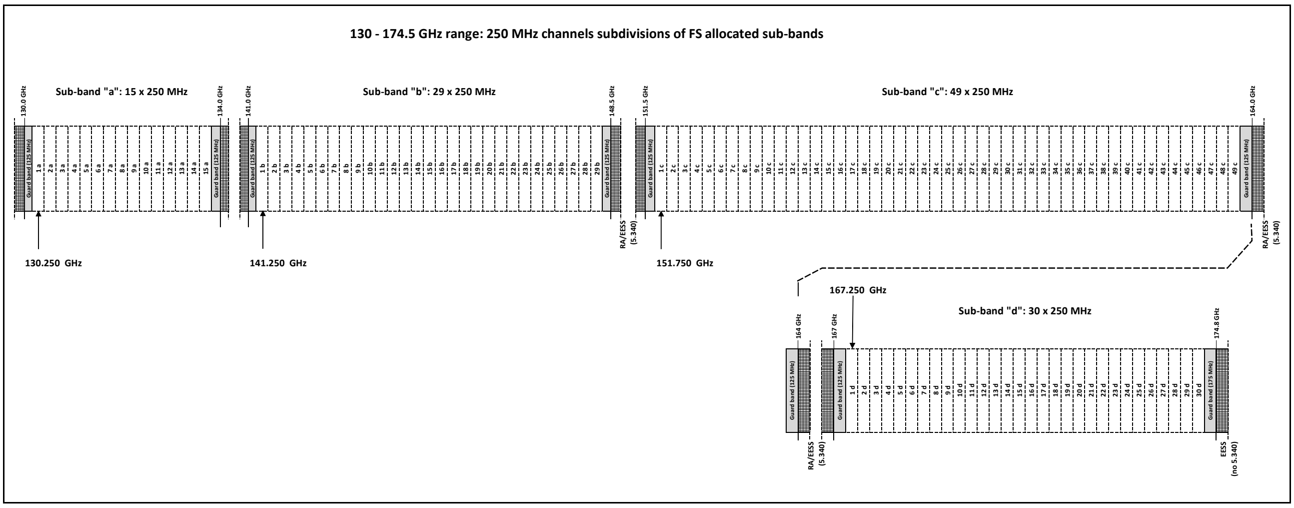

Figure 1: Basic channels raster for FS use in the 130-174.8 GHz band.

Figure 1: shows the subdivision of the available bands into 250 MHz elementary channels; at least 125 MHz guard bands are provided.

Centre frequency of channels can be obtained as follows

$F_N = 130 + N*0.250$ GHz	N: 1 to 15	Sub-band “a”
$F_N = 141 + N*0.250$ GHz	N: 1 to 29	Sub-band “b”
$F_N = 151.5 + N*0.250$ GHz	N: 1 to 49	Sub-band “c”
$F_N = 167 + N*0.250$ GHz	N: 1 to 30	Sub-band “d”

ANNEX 2: BLOCK BASED USE EXAMPLES IN THE 130-174.8 GHZ RF BAND

A2.1 BLOCKS EXAMPLE

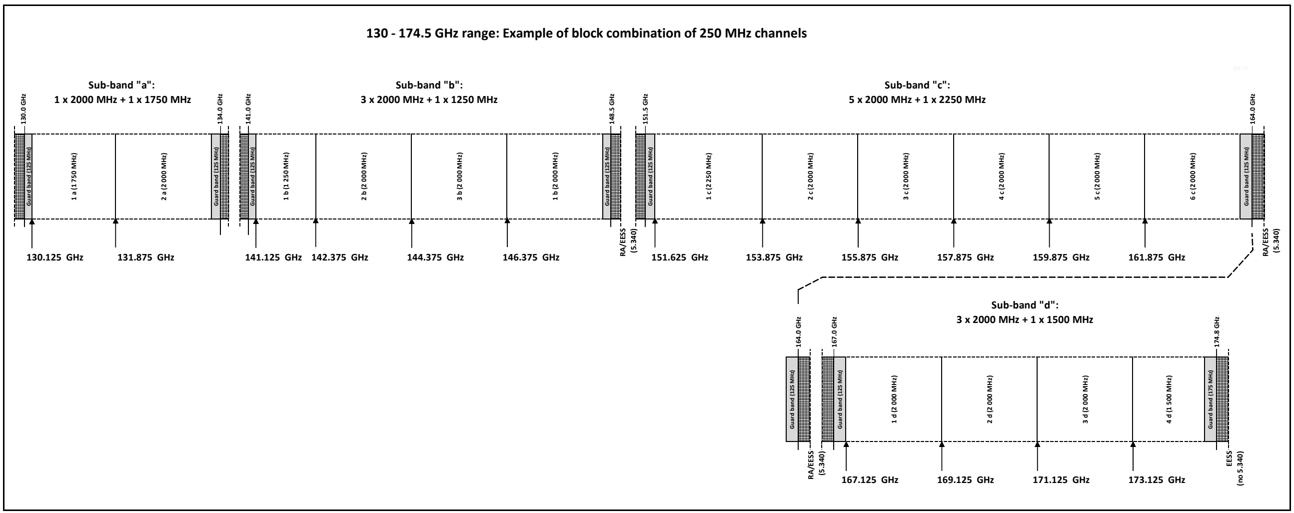

Figure 2: Example showing use of channels aggregated in blocks

A2.2 BLOCK SIZE

Block size should be integer multiple of the basic 250 MHz channel size; in the example given in Figure 2:, 2000 MHz average block size is considered; in principle, no upper limit is given to block size, inside a specific sub-band.

A2.3 USE OF THE CHANNELS/BLOCKS

Blocks can be used either alone or paired with suitable spacing > 15 GHz; e.g. in the example of Figure 2: pairing block 2b with block 4c (with 15.5 GHz duplex spacing) or block 2a with block 2c (with 22 GHz duplex spacing).

Channels inside the block(s), provided that they respect the 250 MHz raster or its aggregations, can be freely used, in symmetric or asymmetric go/return, inside the block(s) e.g. in TDD, full duplex (FD) or flexible reduced duplex (fFDD), in same or each paired block, or in conventional FDD in paired blocks, (see fFDD examples in Figure 3: and Figure 4: and conventional FDD examples in Figure 5: and Figure 6:).

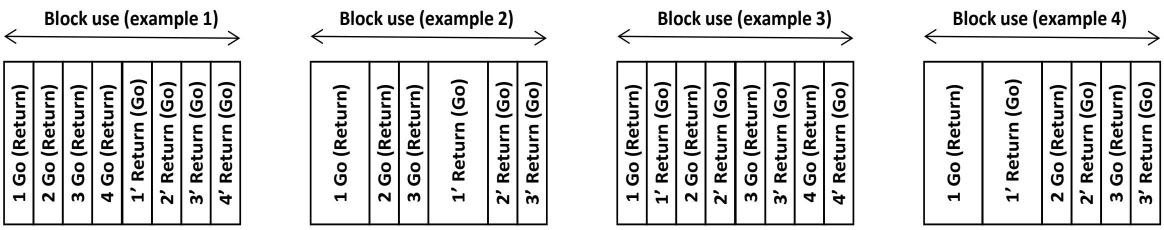

Figure 3: In-block fFDD use examples for symmetric go-return channel size

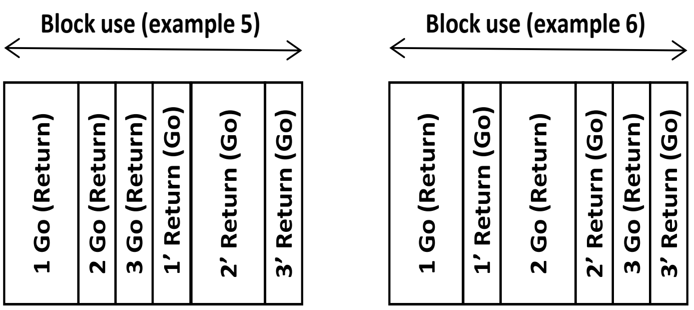

Figure 4: In-block fFDD use examples for asymmetric go-return channel size

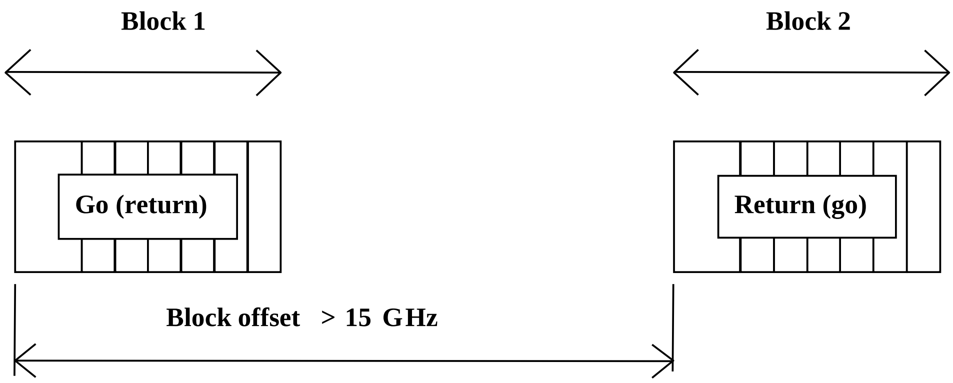

Figure 5: Paired blocks FDD use examples for symmetric go-return channel size

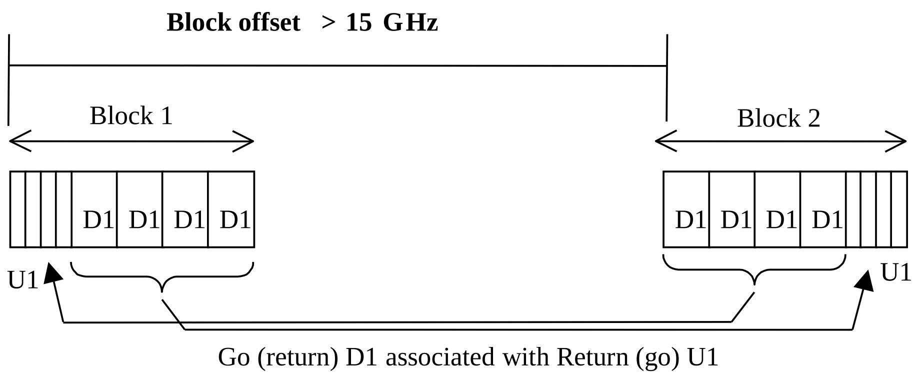

Figure 6: Paired blocks FDD use examples for asymmetric go-return channel size

ANNEX 3: EXAMPLE OF CHANNEL ARRANGEMENT FOR FDD USE IN THE 130-174.8 GHZ RF BAND

The example given in Figure 7: maintains the recommended duplex spacing > 15 GHz.

Due to the odd coupling of the four sub-bands available, large portions have to remain unpaired; in this example the higher sub-band d is kept fully unpaired. However, different solutions could be envisaged.

Unpaired channels could still be aggregated into unpaired blocks for TDD, FD or fFDD use.

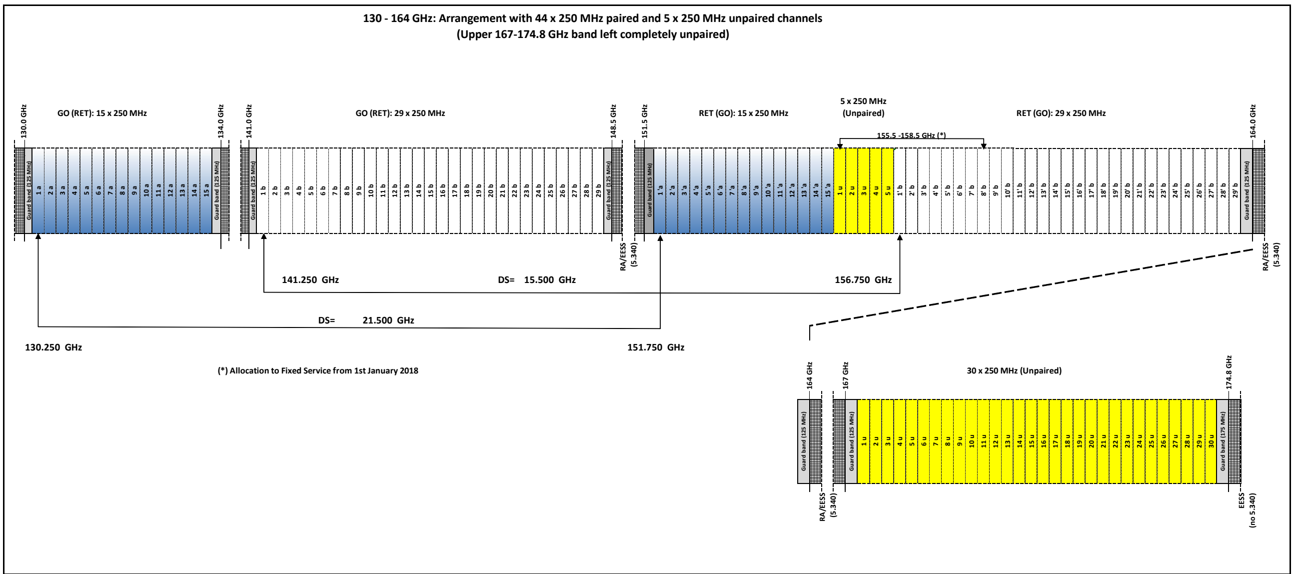

Figure 7: Example showing use of channels as FDD in the 130-174.8 GHz band

ANNEX 4: EXAMPLE OF TECHNICAL BACKGROUND FOR IMPLEMENTING A SELF-COORDINATION APPROACH FOR PP FS

To assist the planning of PP fixed links, self-coordination approach, similar to the “light licensing”, described in ECC Report 80 [3], can be considered. Such regimes do not mean “licence exempt” use, but rather using a simplified set of conventional licensing mechanisms and attributes within the scope decided by administration. This planning is delegated to the licensee.

Administrations intervene for protecting a limited number of sensitive sites while giving greater flexibility elsewhere than it could be allowed without the geographical limitation.

This process requires to record for instance the following set of simple criteria for each authorised link and makes the data available publicly to assist in the identification of operational parameters and to conduct interference analyses:

- Date of application (In order to assign priority);
- Transmit, receive centre frequencies and occupied bandwidth;
- Equipment type, specifying relevant transmitter/receiver parameters;
- Link location (geographic coordinates, height/direction of antenna, etc.);
- The antenna gain and radiation pattern.

Subject to the conditions set by the administration, it is left to the operator to conduct any compatibility studies or coordinate as necessary to ensure that harmful interference is not caused to existing links registered in a national database, keeping that analysis available for any dispute resolution. For example, an operator wishing to install a new link could calculate the interference that the new link will create to the existing links in the database. Then it will be possible to determine whether this new link interferes with existing links. If so, the new link could be replanned to meet the interference requirements of existing links in the database. Otherwise, the new link may be also co-ordinated with existing operators, who might suffer from the interference.

To assist with the resolution of disputes, licenses are issued with a “date of priority”: interference complaints between licensees may therefore be resolved on the basis of these dates of priority (as with international assignments). Consideration of a maximum time frame between the link registration and its effective operational start is a matter for administrations at national level.

ANNEX 5: UNWANTED EMISSION MASK FOR FS SYSTEMS FOR THE PROTECTION OF EESS (PASSIVE) OPERATING IN ADJACENT BANDS WHERE RR FOOTNOTE 5.340 APPLIES

FS transmitters operating in bands adjacent to bands 148.5-151.5 GHz and 164-167 GHz, where footnote **5.340** RR applies, should limit the unwanted emissions at the antenna port, falling into those bands according the following formulas, where *f* is the centre frequency of the 100 MHz reference bandwidth expressed in GHz.

- Emission in band 148.5-151.5 GHz from FS transmitters operating in 141-148.5 GHz:
  - $-41 - 14(f-148.5)$ dBW/100 MHz for $148.55 \le f \le 149.5$ GHz
  - -55 dBW/100 MHz for $149.5 \le f \le 151.45$ GHz
- Emission in band 148.5-151.5 GHz from FS transmitters operating in 151.5-164 GHz:
  - -55 dBW/100 MHz for $148.55 \le f \le 150.5$ GHz
  - $-41 - 14(151.5 - f)$ dBW/100 MHz for $150.5 \le f \le 151.45$ GHz
- Emission in band 164-167 GHz from FS transmitters operating in 151.5-164 GHz:
  - $-41 - 14(f-164)$ dBW/100 MHz for $164.05 \le f \le 165$ GHz
  - -55 dBW/100 MHz for $165 \le f \le 166.95$ GHz
- Emission in band 164-167 GHz from FS transmitters operating in 167-174.8 GHz:
  - -55 dBW/100 MHz for $164.05 \le f \le 166$ GHz
  - $-41 - 14(167 - f)$ dBW/100 MHz for $166 \le f \le 166.95$ GHz

Graphically, the above formulas can be represented by the following figures, where the lower and the higher 100 MHz reference bandwidth slots are intended to be centred at 50 MHz inside the EESS band edges.

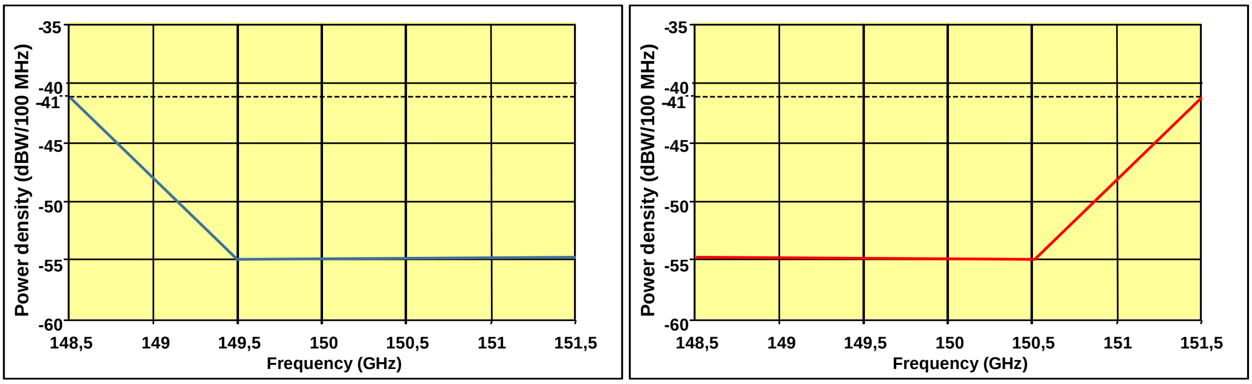

Figure 8: Unwanted emissions in 148.5 – 151.5 band:
from FS operating in 141-148.5 GHz **from FS operating in 151.5-164 GHz**

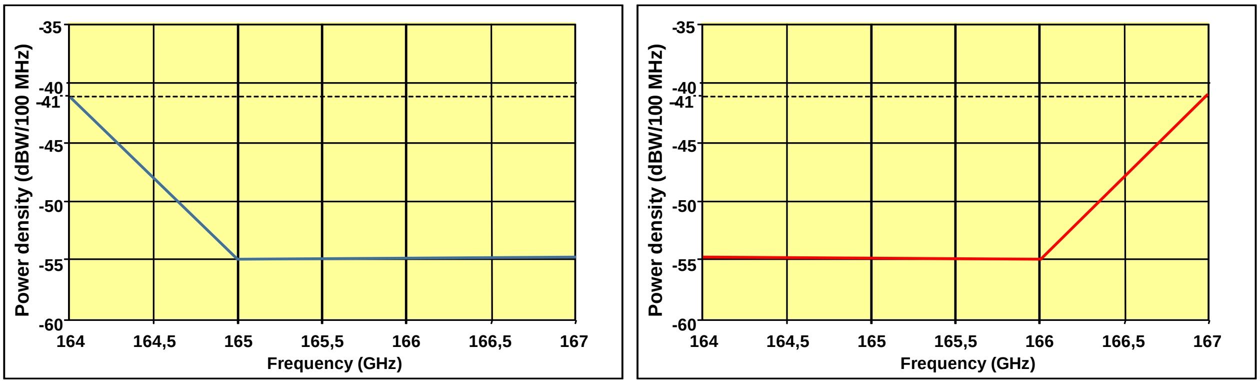

Figure 9: Unwanted emissions in 164 – 167 band
from FS operating in 151.5-164 GHz **from FS operating in 167-174.8 GHz**

ANNEX 6: LIST OF REFERENCE

This Annex contains the list of relevant reference documents.

[1] ITU-R Recommendation P.838-3 Specific attenuation model for rain for use in prediction methods, March 2005
[2] ECC/REC(05)07 Radio frequency channel arrangements for Fixed Service Systems operating in the bands 71-76 GHz and 81-86 GHz, February 2009
[3] ECC Report 80 Enhancing harmonisation and introducing flexibility in the spectrum regulatory framework, March 2006
[4] ECC Report 124 Coexistence between Fixed Service operating in 71-76 / 81-86 GHz and the passive services, September 2008
[5] ECC/REC(01)05 List of parameters of digital point-to-point fixed radio links used for national planning, February 2010
[6] ECC Report 198 Adaptive modulation and ATPC operations in fixed point-to-point systems - Guideline on coordination procedures, May 2013
[7] ECC Report 258 Guidelines on how to plan LoS MIMO for Point-to-Point Fixed Service Links, January 2017
[8] ITU-R Recommendation P.676-11 Attenuation by atmospheric gases, September 2016
[9] ECC Report 211 Technical assessment of the possible use of asymmetrical point-to-point links, February 2014
[10] ERC Report 025, The European table of frequency allocations and applications in the frequency range 8.3 kHz to 3000 GHz (ECA Table)
[11] ITU Radio Regulations, Edition of 2016