



## Analysis of Spectrum, License Schemes and Network Scenarios in the RF bands above 174,8 GHz (standards.iteh.ai)

ETSI GR mWT 022 V1.1.1 (2021-04)  
<https://standards.iteh.ai/catalog/standards/sist/7e247ab5-bac8-4f52-9c0c-77a8b4f2f797/etsi-gr-mwt-022-v1-1-1-2021-04>

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**Reference**DGR/mWT-0022

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**Keywords**mWT, regulation

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## Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) millimetre Wave Transmission (mWT).

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## Executive summary

The present document provides information about RF frequency range above 174,8 GHz, which have not been specifically addressed by an FS related deliverable by ETSI, nor any frequency plan is available by CEPT/ITU-R.

The analyses include an overview of normative status, regarding current status, foreseen activities for the Radio Conferences (clause 4), existing deliverables from various SDOs (clause 5), propagation characteristics (clause 6). In clause 7, a description of possible applications is provided, in clause 8 an overview of possible future applications is addressed.

Trials and projects are subjects of clauses 9 and 10, while clause 11 deals with licensing, suggesting a flexible regime as appropriate to cover this frequency range. Finally, clause 12 provides some technology related information.

## Introduction

Within the scope of telecommunication, frequency bands above 170 GHz are not yet being commercially exploited nor fully covered by standards from all Standards Developing Organizations (SDOs).

The frequency band allocation in Article 5 of the ITU-R Radio Regulations [i.1] is shown in table 1, for the Fixed Service, which is allocated as primary in all the three Regions in RF bands 191,8-200 GHz, 209-217 GHz, 217-226 GHz, 231,5-232 GHz, 232-235 GHz, 238-240 GHz, 240-241 GHz, 252-265 GHz 265-275 GHz.

**Table 1: ITU Table of Frequency Allocation (Radio Regulations 2016) -  
RF sub bands allocated to FS as primary service**

| Allocation to services |                                |             |
|------------------------|--------------------------------|-------------|
| Band [GHz]             | Region 1 - Region 2 - Region 3 | Width [GHz] |
| 191,8-200              | FIXED                          | 8,2         |
| 209-217                | FIXED                          | 8           |
| 217-226                | FIXED                          | 9           |
| 231,5-232              | FIXED                          | 0,5         |
| 232-235                | FIXED                          | 3           |
| 238-240                | FIXED                          | 2           |
| 240-241                | FIXED                          | 1           |
| 252-265                | FIXED                          | 13          |
| 265-275                | FIXED                          | 10          |

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# 1 Scope

The present document is intended to provide an analysis of Spectrum, License Schemes and Network Scenarios in the RF bands above 174,8 GHz, including current activities ongoing, foreseen applications and available documents addressing frequency ranges above the current D band, to support possible utilization of these frequencies by FS in next future.

## 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] ITU-R Radio Regulations 2016.

NOTE: Available at <https://www.itu.int/pub/R-REC-RR-2016>.

[i.2] Recommendation ITU-R F.699: "Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to 86 GHz".

NOTE: Available at <https://www.itu.int/rec/R-REC-F.699/en>.

[i.3] Recommendation ITU-R F.1245: "Mathematical model of average and related radiation patterns for line-of-sight point-to-point fixed wireless system antennas for use in certain coordination studies and interference assessment in the frequency range from 1 GHz to 86 GHz".

NOTE: Available at <https://www.itu.int/rec/R-REC-F.1245/en>.

[i.4] Recommendation ITU-R F.1336: "Reference radiation patterns of omnidirectional, sectoral and other antennas for the fixed and mobile service for use in sharing studies in the frequency range from 400 MHz to about 70 GHz".

NOTE: Available at <https://www.itu.int/rec/R-REC-F.1336/en>.

[i.5] Report ITU-R F.2323: "Fixed service use and future trends".

NOTE: Available at <https://www.itu.int/pub/R-REP-F.2323-1-2017>.

[i.6] Report ITU-R F.2416: "Technical and operational characteristics and applications of the point-to-point fixed service applications operating in the frequency band 275-450 GHz".

NOTE: Available at <https://www.itu.int/pub/R-REP-F.2416-2018>.

[i.7] Report ITU-R M.2417-0: "Technical and operational characteristics of land-mobile service applications in the frequency range 275-450 GHz".

NOTE: Available at <https://www.itu.int/pub/R-REP-M.2417-2017>.

- [i.8] Recommendation ITU-R P.525-4 (08/2019): "Calculation of free-space attenuation".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.525-4-201908-I/en>.
- [i.9] Recommendation ITU-R P.530-17 (12/2017): "Propagation data and prediction methods required for the design of terrestrial line-of-sight systems".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.530-17-201712-I/en>.
- [i.10] Recommendation ITU-R P.676-12: "Attenuation due to atmospheric gases".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.676-12-201908-I/en>.
- [i.11] Recommendation ITU-R P.837: "Characteristics of precipitation for propagation modelling".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.837/en>.
- [i.12] Recommendation ITU-R P.838-3: "Specific attenuation model for rain for use in prediction methods".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.838-3-200503-I/en>.
- [i.13] Recommendation ITU-R P.840-8 (08/2019): "Attenuation due to clouds and fog".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.840-8-201908-I/en>.
- [i.14] Recommendation ITU-R P.1238-10 (08/2019): "Propagation data and prediction methods for the planning of indoor radiocommunication systems and radio local area networks in the frequency range 900 MHz to 100 GHz".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.1238-10-201908-I/en>.
- [i.15] Recommendation ITU-R P.1411-10 (08/2019): "Propagation data and prediction methods for the planning of short-range outdoor radiocommunication systems and radio local area networks in the frequency range 300 MHz to 100 GHz".
- NOTE: Available at <https://www.itu.int/rec/R-REC-P.1411-10-201908-I/en>.
- [i.16] Report ITU-R P.2406-1: "Studies for short-path propagation data and models for terrestrial radiocommunication systems in the frequency range 6 GHz to 450 GHz".
- NOTE: Available at <https://www.itu.int/pub/R-REP-P.2406-1-2019>.
- [i.17] Report ITU-R RA.2189: "Sharing between the radio astronomy service and active services in the frequency range 275-3 000 GHz".
- NOTE: Available at <https://www.itu.int/pub/R-REP-RA.2189-1-2018>.
- [i.18] Recommendation ITU-R RA.1860: "Preferred frequency bands for radio astronomical measurements in the range 1-3 THz".
- NOTE: Available at <https://www.itu.int/rec/R-REC-RA.1860-0-201001-I/en>.
- [i.19] Report ITU-R RS.2194: "Passive bands of scientific interest to EESS/SRS from 275 to 3 000 GHz".
- NOTE: Available at <https://www.itu.int/pub/R-REP-RS.2194-2010>.
- [i.20] Report ITU-R RS.2431: "Technical and operational characteristics of EESS (passive) systems in the frequency range 275-450 GHz".
- NOTE: Available at <https://www.itu.int/pub/R-REP-RS.2431-2019>.
- [i.21] Report ITU-R SM.2352-0: "Technology trends of active services in the frequency range 275-3 000 GHz".
- NOTE: Available at <https://www.itu.int/pub/R-REP-SM.2352-2015>.

- [i.22] Report ITU-R SM.2450-0: "Sharing and compatibility studies between land-mobile, fixed and passive services in the frequency range 275-450 GHz".
- NOTE: Available at <https://www.itu.int/pub/R-REP-SM.2450-2019>.
- [i.23] ETSI White Paper No. 15 (July 2016): "mmWave Semiconductor Industry Technologies: Status and Evolution".
- NOTE: Available at [http://www.etsi.org/images/files/ETSIWhitePapers/etsi\\_wp15\\_mwt\\_semiconductor\\_technology.pdf](http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp15_mwt_semiconductor_technology.pdf).
- [i.24] ETSI TR 103 498: "System Reference document (SRdoc); Short Range Devices (SRD) using Ultra Wide Band (UWB); Transmission characteristics; Technical characteristics for SRD equipment using Ultra Wide Band technology (UWB); Radiodetermination application within the frequency range 120 GHz to 260 GHz".
- NOTE: Available at [https://www.etsi.org/deliver/etsi\\_tr/103400\\_103499/103498/01.01.01\\_60/tr\\_103498v010101p.pdf](https://www.etsi.org/deliver/etsi_tr/103400_103499/103498/01.01.01_60/tr_103498v010101p.pdf).
- [i.25] CEPT Report 70: "In response to the EC Permanent Mandate on the "Annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by short range devices".
- NOTE: Available at <https://docdb.cept.org/document/9684>.
- [i.26] Recommendation ERC 70-03: "Relating to the use of Short Range Devices (SRD)".
- NOTE: Available at <https://docdb.cept.org/download/25c41779-cd6e/Rec7003e.pdf>.
- [i.27] ERC Report 25: "The European table of frequency allocations and utilisations in the frequency range 8.3 kHz to 3000 GHz".
- NOTE: Available at <https://docdb.cept.org/download/2ca5fcbd-4090/ERCReport025.pdf>.
- [i.28] IEEE Std 802.15.3™-2017: "IEEE Standard for High Data Rate Wireless Multi-Media Networks - Amendment 1: High-Rate Close Proximity Point-to-Point Communications".
- NOTE: Available at <https://ieeexplore.ieee.org/document/7942281>.
- [i.29] ETSI GR mWT 018: "Analysis of Spectrum, License Schemes and Network Scenarios in the W-band".
- NOTE: Available at [https://www.etsi.org/deliver/etsi\\_gr/mWT/001\\_099/018/01.01.01\\_60/gr\\_mWT018v010101p.pdf](https://www.etsi.org/deliver/etsi_gr/mWT/001_099/018/01.01.01_60/gr_mWT018v010101p.pdf).
- [i.30] Commission Implementing Decision (EU) 2019/1345 of 2 August 2019 amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices.
- NOTE: Available at [https://eur-lex.europa.eu/eli/dec\\_impl/2019/1345/oj](https://eur-lex.europa.eu/eli/dec_impl/2019/1345/oj).
- [i.31] APT/AWG/REP-66(Rev.1): "Short range radiocommunication systems and application scenarios operating in the frequency range 275 - 1000 GHz".
- NOTE: Available at [https://www.apr.int/sites/default/files/APT-AWG-REP-66Rev.1\\_SRD\\_System\\_in\\_275-1000GHZ.docx](https://www.apr.int/sites/default/files/APT-AWG-REP-66Rev.1_SRD_System_in_275-1000GHZ.docx).
- [i.32] Recommendation ITU-R F.758: "System parameters and considerations in the development of criteria for sharing or compatibility between digital fixed wireless systems in the fixed service and systems in other services and other sources of interference".
- NOTE: Available at <https://www.itu.int/rec/R-REC-F/recommendation.asp?lang=en&parent=R-REC-F.758>.
- [i.33] ITU-R Resolution 731 (REV.WRC 19): "Consideration of sharing and adjacent-band compatibility between passive and active services above 71 GHz".
- NOTE: Available at <https://www.itu.int/net/ITU-R/conferences/docs/ties/res-731-en.pdf>.

[i.34] CPM Report to the 2019 World Radiocommunication Conference.

NOTE: Available at <https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R16-WRC19-C-0003>.

## 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:

|      |                                          |
|------|------------------------------------------|
| AI   | Agenda Item                              |
| APT  | Asia Pacific Telecommunity               |
| BBU  | Baseband Unit                            |
| BER  | Bit Error Ratio                          |
| BPSK | Binary Phase Shift Keying                |
| BS   | Base Station                             |
| BW   | BandWidth                                |
| CPM  | Conference Preparatory Meeting           |
| DHBT | Double Heterojunction Bipolar Transistor |
| ECA  | European Common Allocation               |
| EESS | Earth Exploration Satellite Service      |
| EIA  | Electronic Industries Alliance           |
| EIRP | Effective Isotropic Radiated Power       |
| FDD  | Frequency Division Duplex                |
| FS   | Fixed Service                            |
| FWS  | Fixed Wireless System                    |
| HBT  | Heterojunction Bipolar Transistor        |
| HEMT | Hi Electron Mobility Transistor          |
| IMT  | International Mobile Telecommunications  |
| ISS  | Inter-Satellite Service                  |
| JAXA | Japan Aerospace Exploration Agency       |
| LMS  | Land Mobile Systems                      |
| LO   | Local Oscillator                         |
| LOS  | Line Of Sight                            |
| LPR  | Level Probing Radars                     |
| LTE  | Long Term Evolution                      |
| MAC  | Media Access Control                     |
| nLOS | near Line Of Sight                       |
| NLOS | Non Line Of Sight                        |
| PHY  | Physical Layer                           |
| QAM  | Quadrature Amplitude Modulation          |
| RA   | Radio Astronomy                          |
| RAS  | Radio Astronomy Service                  |
| RF   | Radio Frequency                          |
| RR   | Radio Regulations                        |
| RRH  | Remote Radio Head                        |
| SDO  | Standards Developing Organization        |
| SOI  | Silicon On Insulator                     |
| SRD  | Short Range Device                       |
| TDD  | Time Division Duplex                     |

|      |                               |
|------|-------------------------------|
| TWTA | Traveling-Wave Tube Amplifier |
| UWB  | Ultra Wide Band               |
| WLAN | Wireless LAN                  |
| WRC  | World Radio Conference        |

## 4 RF bands related studies

### 4.1 Highlights

In the search for more spectrum, all wireless applications are already using higher frequencies than the traditional microwave bands, and the use of will increase. The frequency bands above 174,8 GHz are under consideration for large volume applications supporting services that require high speed and huge bandwidths.

### 4.2 Frequency allocation

#### 4.2.0 Generalities

RF bands allocation to various services, including Fixed Service (FS), by the ITU-R Radio Regulations 2016 [i.1], in the bands above 174,8 GHz, are shown in table 2, followed by related footnotes.

It should be considered that the overall range contains some fragmentation, such as the extension of continuous sub-bands allocated to FS presents a spread from 0,5 GHz to 13 GHz, depending on frequency intervals. Such fragmentation, which is aligned with ITU-R Radio Regulations [i.1] should be, kept into account, when considering possibility to use wide continuous RF bands to provide very high transmission capacities in future.

#### 4.2.1 ITU-R Radio Regulations

ITU-R Radio Regulations [i.1] is the highest level document containing provisions which are applied worldwide. They are revised by the WRC conferences, which are held every 4 years. Between most important provisions for the radiocommunication services, they contain, in Article 5, the allocation of frequency ranges to the various services, indicating their priority (name in uppercase letters indicate that the service is primary in that band, lowercase letters means secondary service in that band). Frequency intervals can be allocated to one or more services, with same for different status.

Table 2 shows the frequency ranges where FS is allocated as primary, together with the other services which are also allowed to use same frequency intervals, with their state. Just below the table, footnotes are reported, as indicated in the table, where additional info can be found.

**Table 2: ITU Table of Frequency Allocation (Radio Regulations 2016 [i.1])**

| Allocation to services |                                                                                               |
|------------------------|-----------------------------------------------------------------------------------------------|
| Band [GHz]             | Region 1 - Region 2 - Region 3                                                                |
| 174.8-182              | EARTH EXPLORATION-SATELLITE (passive)<br>INTER-SATELLITE 5.562H<br>SPACE RESEARCH (passive)   |
| 182-185                | EARTH EXPLORATION-SATELLITE (passive)<br>RADIO ASTRONOMY<br>SPACE RESEARCH (passive)<br>5.340 |
| 185-190                | EARTH EXPLORATION-SATELLITE (passive)<br>INTER-SATELLITE 5.562H<br>SPACE RESEARCH (passive)   |
| 190-191.8              | EARTH EXPLORATION-SATELLITE (passive)<br>SPACE RESEARCH (passive)<br>5.340                    |
| 191.8-200              | FIXED<br>INTER-SATELLITE<br>MOBILE 5.558                                                      |

| Allocation to services |                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Band [GHz]             | Region 1 - Region 2 - Region 3                                                                                           |
|                        | MOBILE-SATELLITE<br>RADIONAVIGATION<br>RADIONAVIGATION-SATELLITE<br>5.149 5.341 5.554                                    |
| 200-209                | EARTH EXPLORATION-SATELLITE (passive)<br>RADIO ASTRONOMY<br>SPACE RESEARCH (passive)<br>5.340 5.341 5.563A               |
| 209-217                | FIXED<br>FIXED-SATELLITE (Earth-to-space)<br>MOBILE<br>RADIO ASTRONOMY<br>5.149 5.341                                    |
| 217-226                | FIXED<br>FIXED-SATELLITE (Earth-to-space)<br>MOBILE<br>RADIO ASTRONOMY<br>SPACE RESEARCH (passive) 5.562B<br>5.149 5.341 |
| 226-231.5              | EARTH EXPLORATION-SATELLITE (passive)<br>RADIO ASTRONOMY<br>SPACE RESEARCH (passive)<br>5.340                            |
| 231.5-232              | FIXED<br>MOBILE<br>Radiolocation                                                                                         |
| 232-235                | FIXED<br>FIXED-SATELLITE (space-to-Earth)<br>MOBILE<br>Radiolocation                                                     |
| 235-238                | EARTH EXPLORATION-SATELLITE (passive)<br>FIXED-SATELLITE (space-to-Earth)<br>SPACE RESEARCH (passive)<br>5.563A 5.563B   |
| 238-240                | FIXED<br>FIXED-SATELLITE (space-to-Earth)<br>MOBILE<br>RADIOLOCATION<br>RADIONAVIGATION<br>RADIONAVIGATION-SATELLITE     |
| 240-241                | FIXED<br>MOBILE<br>RADIOLOCATION                                                                                         |
| 241-248                | RADIO ASTRONOMY<br>RADIOLOCATION<br>Amateur<br>Amateur-satellite<br>5.138 5.149                                          |
| 248-250                | AMATEUR<br>AMATEUR-SATELLITE<br>Radio astronomy<br>5.149                                                                 |
| 250-252                | EARTH EXPLORATION-SATELLITE (passive)<br>RADIO ASTRONOMY<br>SPACE RESEARCH (passive)<br>5.340 5.563A                     |
| 252-265                | FIXED<br>MOBILE<br>MOBILE-SATELLITE (Earth-to-space)<br>RADIO ASTRONOMY<br>RADIONAVIGATION<br>RADIONAVIGATION-SATELLITE  |
| 265-275                | FIXED<br>FIXED-SATELLITE (Earth-to-space)<br>MOBILE                                                                      |