CEPT ECC
Electronic Communications Committee

CEPT Report 088

Report from CEPT to the European Commission in response to the Mandate on shared use of the 3800-4200 MHz frequency band by low/medium power terrestrial wireless broadband systems (WBB LMP) providing local-area network connectivity

approved 8 November 2024

0 EXECUTIVE SUMMARY

In this Report, the technical feasibility of the shared use of the 3800-4200 MHz frequency band by low/medium power terrestrial wireless broadband systems (WBB LMP) providing local-area network connectivity was assessed, in line with the objective of the EC Mandate.

CEPT noted that a few CEPT countries have already taken national initiatives in the 3800-4200 MHz frequency band, as well as in parts of the 3400-3800 MHz frequency band, to respond to specific local/vertical market demands that may not be met in the frequency bands that have already been harmonised for 5G ECS.

The 400 MHz available in the 3800-4200 MHz frequency band can enable the deployment of terrestrial wireless broadband systems to provide local area connectivity for a variety of services. For the various types of use cases there may be various needs of UL/DL resources and different technologies, resulting in unsynchronised operation. The wide range of local use cases, used across different industrial and non-industrial environments both indoors and outdoors, will benefit from harmonised technical conditions.

CEPT studies in ECC Report 358 [1] and ECC Report 362 [2] have considered the compatibility with and protection of all incumbent services, including their future deployments, within the band and in adjacent frequency bands.

0.1 WBB LMP MAIN CHARACTERISTICS AND ASSUMPTIONS

Studies and analysis have considered a range of agreed WBB LMP parameters (e.i.r.p., antenna height, antenna gain, emission and reception masks, etc.) covering both AAS and non-AAS scenarios for medium power base stations, but only non-AAS for low power base stations. Two WBB LMP technologies have been considered, one based on 3GPP technology and the other based on DECT-2020 NR. All studies assume an authorisation regime where the location of the WBB LMP networks or base stations is known.

For the purpose of studies, the following base station power levels for 3GPP WBB LMP were defined:

- low power with up to 31 dBm/100 MHz e.i.r.p.;
- medium power with up to 51 dBm/100 MHz e.i.r.p.

These power levels are also proposed to be a part of the harmonised technical conditions.

For studies relating to DECT-2020 NR, the maximum e.i.r.p. of 23 dBm was assumed in a channel bandwidth of 6.912 MHz.

For studies based on 3GPP technology, the technical characteristics were based on current ETSI technical specifications. DECT-2020 NR parameters were taken from ETSI TS 103 636-2 v1.4 [4].

0.2 COEXISTENCE WITH FIXED SATELLITE SERVICE (FSS)

Fixed satellite service (FSS) is a primary user of the 3800-4200 MHz frequency range in Europe. With the introduction of 5G in the 3400-3800 MHz frequency band in Europe, many FSS stations which operated below 3800 MHz have migrated to the 3800-4200 MHz frequency band. The 3800-4200 MHz frequency band is crucial for FSS due to its unique characteristics, including wide geographic coverage over continents and resistance to rain fade. A limited number of FSS earth stations have been maintained in the frequency band below 3800 MHz, since this is the same service as above 3800 MHz, feasibility of FSS below 3800 MHz is considered to be covered by the conclusions of in-band FSS. CEPT studies assumed that the location of FSS receiving earth stations is known.

The results of the various studies show that the separation distances required between WBB LMP and FSS can vary significantly depending on the assumptions taken. Studies were performed with and without clutter loss (signal strength being blocked by nearby obstacles such as buildings) at either site of the path. Two FSS protection criteria were also considered, a long-term criterion as well as a short-term criterion resulting in considerably larger separation distances.

When using the long-term protection criterion, the generic studies (without terrain data) show separation distances up to 48 km for WBB medium power and 33 km for WBB low power. When clutter loss at one end of the propagation path is assumed, the corresponding distances are up to 18 km (medium power) and 4.7 km (low power). Studies using real terrain data show separation distances in the range of 5.3–17.2 km for WBB low power and 17.5–70 km for WBB medium power stations. Results for DECT-2020 NR are consistent with the WBB low power separation distances noted above when a transmitter power of 23 dBm is considered (i.e. 3 km for the long-term protection criterion with clutter applied at one end of the propagation path).

When the result is evaluated against the short-term protection criterion, the protection distance was found to be up to 277 km (medium power, flat terrain, and no clutter loss assumed). A case study on one specific earth station indicated separation distances of up to 9.3 km for WBB low power and 35 km for WBB medium power stations.

In conclusion, it is not possible to define generic technical conditions that guarantee the protection of FSS. To ensure the protection of current and future deployment of FSS, careful planning and case-by-case analysis is needed, also in considering appropriate mitigation techniques. In addition, due to the large separation distances that may be necessary, the protection of FSS within the frequency band as well as below 3800 MHz cannot always be managed at national level only, but may also require cross-border coordination on a case-by-case basis as well as bilateral or even multilateral agreements between neighbouring countries.

CEPT intends to develop guidelines in order to help administrations to address coordination and planning both at national level and with the neighbouring countries.

0.3 COEXISTENCE WITH FIXED SERVICE (FS)

Fixed service (FS) is a primary user of the 3800-4200 MHz frequency range in Europe including both military and civil usages. Civil use is primarily fixed point-to-point microwave links connecting different points in a network, such as data centres or remote locations. Military usage includes fixed microwave links that support military communications and surveillance systems. CEPT studies assumed that the locations of FS stations are known.

In 2023 a questionnaire on the current and planned use of the frequency band 3800-4200 MHz in Europe has been submitted to the CEPT administrations. A total of 14 CEPT countries have reported civil FS usage in the 3800-4200 MHz frequency band, primarily fixed point-to-point microwave links. One country reported significant usage with approximately 400 point-to-point links, while the other 13 countries have reported between approximately 2 and 120 point-to-point links. Some administrations plan to continue using the band for fixed links, as well as possible new ones, since the migration to higher bands with different propagation characteristics would be very costly.

For WBB medium power base stations, studies assuming flat terrain indicate that required separation distances in the direction of the FS main lobe could range up to 113 km. In flat terrain if the WBB medium power base station site is in the side lobe of the receiving FS antenna, the required separation distance will be shorter (up to 69 km). For WBB low power base stations, studies assuming flat terrain indicate that required separations distances in the direction of the FS main lobe could range up to 46.3 km. In this case clutter is applied to the WBB side for the low power base station as the maximum antenna height is limited to 10 m. For DECT-2020 NR, when using comparable assumptions to WBB low power base station case, the required separation distance is 37 km. Case studies performed show the importance to consider real terrain data, because real terrain can either hinder or favour propagation significantly. This then affects the required separation distances and areas where WBB LMP deployment needs to be excluded (exclusion areas).

In conclusion, it is not possible to define generic technical conditions that guarantee the protection of FS. Careful planning and case-by-case analysis is needed, in combination of considering appropriate mitigation techniques, to ensure the protection of current and future deployment of FS. In addition, due to the large separation distances that may be necessary, the protection of FS cannot always be managed at national level only, but may also require cross-border coordination on a case-by-case basis as well as bilateral or even multilateral agreements between neighbouring countries.

CEPT intends to develop guidelines in order to help administrations to address coordination and planning both at national level and with the neighbouring countries.

0.4 COEXISTENCE WITH WBB ECS BELOW 3800 MHZ

The 3400-3800 MHz band has been harmonised for WBB ECS in CEPT under ECC Decision (11)06 [3] and in the EU under Decision 2008/411/EC as amended [5] and is recognised to be the 5G primary band in Europe. It is crucial that the WBB ECS service is adequately protected.

In order to manage coordination with WBB ECS below 3800 MHz, administrations may consider for example synchronisation where possible (noting some foreseen WBB LMP technology could not be synchronised with WBB ECS), pfd limits, separation distance and/or frequency separation requirements, etc.

For the various types of local use cases, there may be various needs of UL/DL resources and/or different technologies. The studies are mainly based on the assumption of no synchronisation between WBB LMP networks in the frequency band 3800-4200 MHz and WBB ECS below 3800 MHz. Adjacent channel coexistence between 3GPP-based synchronised WBB LMP networks and WBB ECS is considered as being covered by ETSI technical specifications and thus is not studied in this Report.

CEPT plans to develop recommendations for administrations to provide guidance on the protection approach for the coexistence with WBB ECS below 3800 MHz. There may be also a need to develop relevant cross-border recommendations.

0.5 COEXISTENCE WITH RADIO ALTIMETERS ABOVE 4200 MHZ

The frequency band 4200-4400 MHz is globally allocated to the aeronautical radio navigation service (ARNS), and the band is used by radio altimeters installed on board aircrafts. Radio altimeters provide precise height measurements critical for various safety functions in aviation, including automated landing.

Coexistence with radio altimeters above 4200 MHz is covered in ECC Report 362 [2]. The base line studies were conducted for RA heights of 200 and 1000 feet, which corresponds to the heights for which data on the RA were provided. As a sensitivity analysis, RA heights below 200 feet was studied, where ITT values for 200 feet were assumed also for heights below 200 feet.

The main scenario was modelled as a nominal Instrument Landing System (ILS) approach with associated Obstacle Limitation Surface (OLS).

Two sets of parameters were used as the baseline for the studies:

- Parameter Set 1 contains data on a variety of radio altimeter models primarily derived from AVSI Report Volume III;
- Parameter Set 2 contains data for the least resilient radio altimeter model based on AVSI Report Volume I and Volume II.

The Parameter Sets also use different assumptions for the radio altimeter antenna.

Based on the above radio altimeter parameters, as well as typical base station parameters and set up, ECC Report 362 derived the following conclusions for the modelled ILS approach scenario:

- Studies using Parameter Set 1 or Set 2 at 200 and 1000 feet show sufficient margins covering at least the 6 dB safety margin;
- A study using Parameter Set 2 which apply the 200 feet interference tolerance threshold below 200 feet show that unwanted emissions from base stations operating in 4100-4200 MHz band do not meet the 6 dB safety margin for the modelled beamforming antenna configurations. The same study shows the 6 dB safety margin is fully covered for BS positions greater than 1200 m from the runway threshold or 40 m laterally or with some improved out of band emission levels (Further details are provided in ECC Report 362, annex 3).

There are a number of differences between these results for Parameter Set 1 and 2 However, all studies found that lower heights are more critical than the 1000 feet Radio Altimeter when considering potential interference. In addition, results are particularly sensitive to the assumptions for the Radio Altimeter antenna patterns particularly at high off-axis angles for low heights (below 200 feet).

0.6 COEXISTENCE BETWEEN WBB LMP NETWORKS

Studies have been performed in order to evaluate the coexistence between two WBB LMP networks in the 3800-4200 MHz frequency band. For the various types of local use cases there may be various needs of UL/DL resources and/or different technologies. The studies are mainly based on the assumption of no synchronisation between WBB LMP networks. Indoor-only, outdoor-only and outdoor/indoor deployment scenarios have been considered.

Adjacent channel coexistence between 3GPP-based synchronised WBB LMP networks is considered as being covered by ETSI technical specifications and thus is not studied in this Report.

CEPT plans to develop recommendations for administrations to provide guidance on the coordination approach for the coexistence between WBB LMP local area networks.

0.7 HARMONISED TECHNICAL CONDITIONS

The proposed harmonised technical conditions in this Report are based on the results of the technical studies in ECC Report 358 [1] and in ECC Report 362 [2]. ECC Report 358 concluded that it was not possible to identify a generic set of least restrictive technical conditions that will fit every deployment scenario for shared access in all cases due to a number of factors, such as existing incumbent services and different terrain across CEPT countries.

CEPT has achieved a balance between how much coordination an administration is able to carry out between WBB LMP networks and incumbent services, and how restrictive the harmonised technical conditions on WBB LMP need to be.

The proposed harmonised technical conditions for WBB LMP have been developed assuming an authorisation regime where the location of WBB LMP networks or base stations is known. An authorisation regime where the location is not known is out of scope for the harmonisation proposed in this Report as this situation may create a risk of interference for existing and new WBB ECS base stations below 3800 MHz, fixed links and FSS earth stations as well as between WBB LMP networks.

These conditions include maximum in-block e.i.r.p. limits for WBB low power and medium power base station, in view of ensuring protection, taking into account the long-term development of incumbent users sharing the 3800-4200 MHz frequency band, in particular receiving satellite earth stations and terrestrial fixed links. This does not preclude however local exceptions outside the harmonised technical conditions to be considered by national administrations in specific circumstances, under conditions which are presented in section 5 of this Report. The harmonised technical conditions presented are defined to respect technology neutrality for the operation of WBB LMP.

It has not been possible to define generic technical conditions that alone guarantee the protection of all incumbent services. Careful planning and case-by-case analysis is needed, in combination of considering appropriate mitigation techniques.

In order to facilitate and maximise the opportunities for the deployment of WBB LMP and to manage remaining coordination cases that may not be addressed by the harmonised technical conditions, administrations may want to complement certain aspects of their use of the frequency band 3800-4200 MHz at the national and/or the local level circumstances, for example with synchronisation, pfd limits, separation distance and/or frequency separation requirements. CEPT intends to develop relevant recommendations in order to provide guidelines to administrations as appropriate.

Finally, CEPT supports the current bilateral cross-border coordination process between CEPT countries and will consider the need to develop ECC Recommendations relevant for the 3800-4200 MHz frequency band.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
3GPP	3rd Generation Partnership Project
5G	5th generation of wireless cellular technology
AAS	Active Antenna Systems
ACS	Adjacent Channel Selectivity
ARNS	Aeronautical Radio Navigation Service
AR/XR	Augmented/Extended Reality
CEPT	European Conference of Postal and Telecommunications Administrations
DECT-2020 NR	Digital Enhanced Cordless Telecommunications-2020 New Radio
DL	Downlink
EC	European Commission
ECC	Electronic Communications Committee
EFIS	ECO Frequency Information System
e.i.r.p.	Effective Isotropic Radiated Power Equivalent isotropic radiated power
ETSI	European Telecommunications Standards Institute
FS	fixed service
FSS	fixed satellite service
GPWS	Ground Proximity Warning Systems
ICAO	International Civil Aviation Organization
IoT	Internet of Things
ITT	Interference Tolerance Thresholds
ITU	International Telecommunication Union
LOS	Line of Sight
LP	Low Power
MCL	Minimum Coupling Loss
MFCN	Mobile/Fixed Communications Networks
MP	Medium Power
NFD	Net Filter Discrimination
OLS	Obstacle Limitation Surface

pfd	power flux density
Pmp	Point-to-multi-Point
Ptp	Point-to-Point
RA	Radio Altimeter
RDFT	radio device fixed terminal
RDPT	radio device portable terminal
RR	Radio Regulations
TAWS	Terrain Awareness Warning Systems
TPC	Transmitter Power Control
t.r.p.	total radiated power
UC	Usage Category
UHD	Ultra High Definition
UL	Uplink
VGOS	VLBI (Very Long Baseline Interferometry (VLBI) Global Observing System
WAIC	Wireless Avionics Intra-Communications
WBB ECS	Wireless Broadband Electronic Communications Systems
WBB LMP	low/medium power terrestrial wireless broadband systems providing local-area network connectivity
WRC	World Radio Conference

1 INTRODUCTION

In this Report, the technical feasibility of the shared use of the 3800-4200 MHz frequency band by low/medium power terrestrial wireless broadband systems (WBB LMP) providing local-area network connectivity was assessed, in line with the objective of the EC Mandate.

CEPT noted that a few CEPT countries have already taken national initiatives in the 3800-4200 MHz frequency band, as well as in parts of the 3400-3800 MHz band, to respond to specific local/vertical market demands that may not be met in the frequency bands that have already been harmonised for 5G.

The 400 MHz available in the 3800-4200 MHz frequency band can enable the deployment of terrestrial wireless broadband systems to provide local area connectivity for a variety of services. For the various types of use cases there may be various needs of UL/DL resources and different technologies, resulting in unsynchronised operation. The wide range of local use cases, used across different industrial and non-industrial environments both indoors and outdoors, will benefit from harmonised technical conditions.

Some examples of the non-exhaustive list of use-cases which could utilise the 3800-4200 MHz frequency band are listed below:

Table 1: Examples of WBB LMP use-cases

Local areas services	Connectivity use-case example
Transport	Transport hubs, including for example logistics in ports, and remote control of cranes, vehicles and ships
Manufacturing	Smart factories and warehouses, supporting applications including sensor and machine connectivity, real-time monitoring of production lines, predictive maintenance and automation
Construction	Remote monitoring, site surveys and operations at construction sites
Entertainment and content production	Permanent or temporary production, including multiple UHD video live-streaming and use of AR/XR applications for immersive user experience, multiple camera feeds and control signals within TV production environments (indoors/outdoors)
Education	Schools or campuses, including video streaming in online learning platforms, and the use of AR/XR applications
Health	Hospitals and other medical institutions, for internal communications, including sensors and medical equipment
Utilities	Connectivity for smart grid real-time operations, including network control and optimisation, wind farms as well as remote infrastructure monitoring and management
Smart cities	Connectivity for urban planning and real-time information conveyance
Rural broadband connectivity	Connectivity for industries located in rural environments such as e.g. agriculture, mining and fishing, as well as for local communities through Fixed Wireless Access

2 EXISTING AND PLANNED USE OF 3800-4200 MHZ FREQUENCY BAND AND ADJACENT FREQUENCY BANDS

2.1 FIXED SATELLITE SERVICE

For decades, the fixed satellite service (FSS) has utilised the 3400-4200 MHz and 5850-6725 MHz frequency bands for space-to-Earth (downlink) and Earth-to-space (uplink) links, respectively. FSS earth stations in CEPT countries have mainly used the 3600-3800 MHz and 3800-4200 MHz frequency bands, rather than the lower 3400-3600 MHz frequency band.

With the introduction of 5G in the 3400-3800 MHz frequency band in Europe, CEPT has recommended that administrations consider relocating earth stations operating in the 3400-3800 MHz band to areas without foreseen extensive 5G use, such as urban and suburban areas or along transport routes like roads and railways. In addition, CEPT recommended administrations to avoid authorising new FSS sites in the 3400-3800 MHz frequency band in areas intended for 5G, and instead consider using higher bands above 3800 MHz for future FSS usage. As a result, a limited number of FSS earth stations have been maintained below 3800 MHz frequency band, while many stations have migrated to the 3800-4200 MHz frequency band.

The 3800-4200 MHz band is crucial for FSS due to its unique characteristics, including wide geographic coverage over continents and resistance to rain fade. This band is essential for services provided to inter-tropical regions, and many earth stations are located in Europe for inter-continental communications. Applications include connectivity for enterprises and public institutions, mobile backhauling, and video contribution and distribution including:

- Various international broadcasters use the 3800-4200 MHz frequency band for FSS downlinking of content from Europe to other regions. The successful operation of this system depends on interference-free reception of the downlink signal. Large dish earth stations also need to receive beacon signals transmitted from the satellite for tracking purposes. Additionally, many video contribution links from other regions are received in Europe using the 3800-4200 MHz frequency band before being distributed;
- CEPT is also studying the possibility of exempting small C-band IoT terminals in other frequency bands from individual licensing, which could lead to the need for more gateway earth stations in the 3800-4200 MHz frequency band[1].

Existing FSS earth stations in the 3800-4200 MHz frequency band within Europe are limited in number and well-identified in location. Future new earth station sites can also be expected to be located in well-defined locations. With the introduction of 5G in 3400-3800 MHz, some administrations have implemented national measures to protect earth stations above 3800 MHz in addition to the harmonised technical conditions. These national frameworks provide visibility and legal certainty for the future development of earth stations in the 3800 - 4200 MHz frequency band while also ensuring the development of 5G in the 3400-3800 MHz frequency band.

As the 3800-4200 MHz frequency band is the only remaining part of the C-band for downlink communication, CEPT has assessed and proposed conditions to preserve this band for the long-term development of FSS in accordance with the objectives of the EC Mandate.

2.2 FIXED SERVICE

Fixed service (FS) is a primary user of the 3800-4200 MHz frequency range in Europe, and includes both military and civil usages. Military usage includes fixed microwave links that support military communications and surveillance systems. Military entities use these links for command and control, situational awareness, intelligence, surveillance and reconnaissance and other applications.

Civil use is primarily fixed point-to-point microwave links connecting different points in a network, such as data centres or remote locations. These links are commonly used for broadcast feeder links with high antenna positions, as well as backhaul for various applications such as public safety and emergency services, and transportation systems.

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[1] See Work Item FM44_45 on “Exemption from individual licensing for small IoT transmit-only satellite terminals for land and maritime applications transmitting in the 5850-5875 MHz band and 14.0-14.5 GHz band”

ERC Recommendation 12-08 [6] specifies various paired channel arrangements in the 3600-4200 MHz frequency band for Point-to-Point (Ptp) and Point-to-multi-Point (Pmp) links based on Recommendation ITU-R F.382 [8].

According to ECC Report 173, section A1.3 [7], in the 3800-4200 MHz frequency band, ten administrations have reported Pmp usage and eight administrations Ptp usage. They indicated thousands of Pmp stations in operation, in addition to Ptp links.

In 2023, a questionnaire on the current and planned use of the frequency band 3800-4200 MHz in Europe has been submitted to the CEPT Administrations. A total of 14 CEPT countries have reported FS usage in the 3800-4200 MHz frequency band. The highest reported usage is approximately 400 point-to-point links, mainly used to feed the national TV and radio broadcast networks. The other 13 countries have reported between approximately 2 and 120 point-to-point links. In addition to this, one country reported 5 Pmp links in the band.

In order to facilitate the harmonisation at CEPT level of the 3400-3800 MHz frequency band and the introduction of WBB ECS in the band, some administrations migrated the FS links operating in the 3600-3800 MHz frequency band to the 3800-4200 MHz frequency band.

Some administrations plan to use the band for existing fixed links and possible new ones, while they have no plan to move existing fixed links out of this band. It is considered essential for these links due to its unique propagation characteristics. The migration to higher bands with different propagation characteristics would be very costly and would require reengineering of the transport network without always achieving the same level of reliability.

At least one country has indicated military FS usage in parts of the 3800-4200 MHz frequency band.

2.3 GALILEO – VGOS STATIONS

There is a globally distributed network of VLBI Global Observing System (VGOS) stations, which are highly sensitive passive receivers and are expected eventually to number ~40. Some VGOS observatories are installed around Europe: Wettzell in Germany, Ny-Ålesund in Norway, Flores and Santa Maria in Portugal, Gran Canaria and Yebes in Spain, Onsala in Sweden, Matera in Italy and Metsähovi in Finland. These are part of the European Critical Infrastructure Project Galileo which has to be supported from all European countries.

The start frequencies of these VGOS stations, like type VGOS-992 A8, is 3960.4 MHz (Block A) (see Report ITU-R RA.2507, page 25 [9]).

It is recognised that, for the moment, these observations, which are operating in the spectrum bands of the 2-14 GHz range, have no radio astronomy allocation in 3800-4200 MHz frequency band and therefore cannot claim interference protection on international or European level. Nevertheless, administrations are urged to take all practical steps to protect these observatory operations from harmful interference.

2.4 MOBILE SERVICE BELOW 3800 MHZ

The 3400-3800 MHz frequency band has been harmonised for WBB ECS in CEPT by ECC Decision (11)06 [3] and in the EU by the Decision 2008/411/EC [10] as amended, and is recognised to be the 5G primary band in Europe.

The frequency 3400-3800 MHz band has been auctioned in a majority of CEPT countries (see ECO Report 03 [11] and EU 5G Observatory. Under the relevant authorisations and rights of use granted accordingly, mobile operators have invested heavily to roll out 5G and will continue during the next years. Those networks are widely deployed outdoors typically using AAS. Non-AAS small cells could be also rolled out indoors.

It is crucial that WBB ECS is adequately protected.

2.5 FIXED SATELLITE BELOW 3800 MHZ

With the introduction of 5G in the 3400-3800 MHz frequency band in Europe, CEPT has recommended that administrations consider relocating earth stations operating in the 3400-3800 MHz frequency band from areas with foreseen extensive 5G use. In addition, CEPT recommended administrations to avoid authorising new FSS sites in the 3400-3800 MHz frequency band in areas intended for 5G, and instead consider using higher frequency bands above 3800 MHz for future FSS usage. As a result, only a limited number of FSS earth stations have remained in frequency band below 3800 MHz. As this is the same service as above 3800 MHz, operation of FSS below 3800 MHz is considered to be covered by the in-band sharing studies.

2.6 RADIO ALTIMETERS IN 4200-4400 MHZ

Within the International Telecommunication Union (ITU) Radio Regulations (RR) the frequency band 4200-4400 MHz is globally allocated to the aeronautical radionavigation service (ARNS) and is reserved exclusively for radio altimeters installed on board aircraft and for the associated transponders on the ground by RR footnote No. 5.438.

Radio altimeters are mandated for certain classes of aircraft by aviation regulations and airworthiness requirements. Radio altimeters provide precise height measurements critical for various safety functions in aviation, including automated landing, Ground Proximity Warning Systems (GPWS), Terrain Awareness Warning Systems (TAWS) and collision avoidance.

2.7 AERONAUTICAL MOBILE (R) SERVICE IN 4200-4400 MHZ (WAIC)

The use of the frequency band 4200-4400 MHz by stations in the aeronautical mobile (R) service for Wireless Avionics Intra Communications (WAIC) is secondary to Radio Altimeters and operate on a non-protection, non-interference basis with respect to Radio Altimeters. WAIC systems shall operate in accordance with recognised international aeronautical standards and the use shall be in accordance with Resolution 424 (WRC-15).

3 TECHNICAL FEASABILITY

3.1 INTRODUCTION

The results of the sharing and compatibility studies performed within CEPT, which can be found in ECC Report 358 [1] and ECC Report 362 [2], were used as the basis for the response to the EC Mandate on the shared use of the 3800-4200 MHz frequency band by low/medium power terrestrial wireless broadband systems (WBB LMP) providing local-area network connectivity. The following sections provide consideration on the key assumptions for WBB LMP and the results of the coexistence studies.

Adjacent channel coexistence between 3GPP-based synchronised WBB LMP networks is considered covered by 3GPP/ETSI standardisation. This assumption also accounts for adjacent band operation of these WBB LMP networks in the frequency band 3800-4200 MHz synchronised with WBB ECS below 3800 MHz. Such synchronised coexistence between WBB ECS below 3800 MHz and WBB LMP above 3800 MHz, or between WBB LMP networks in the 3800-4200 MHz frequency band, could be a possible coordination solution for WBB LMP networks based on 3GPP technical specifications.

CEPT has achieved a balance between how much coordination an administration is able to carry out at a local level between WBB LMP networks and incumbent services, and how restrictive the harmonised technical conditions on WBB LMP need to be.

In order to facilitate the deployment of low/medium power terrestrial wireless broadband systems (WBB LMP) providing local-area network connectivity and manage coordination with WBB ECS below 3800 MHz, administrations may consider for example synchronisation where possible (noting some foreseen WBB LMP technology could not be synchronised with WBB ECS), pfd limits, separation distances and/or frequency separation requirements.

The results of relevant studies also show a need for national and cross border coordination to ensure the protection and future evolution on a case-by-case basis of FSS receiving earth stations and of FS sharing the frequency band 3800-4200 MHz with WBB LMP, for managing coexistence between WBB LMP networks, as well as FS and FSS below 3800 MHz.

CEPT will develop ECC Recommendations providing guidance to administrations on relevant mechanisms/solutions to be further implemented at national and bilateral/multilateral level to manage coexistence between:

- WBB LMP and FSS earth stations;
- WBB LMP and FS links;
- WBB LMP and WBB ECS in the 3400-3800 MHz frequency band;
- WBB LMP networks;
- WBB LMP and radio altimeters in the 4200-4400 MHz frequency band.

3.2 TECHNICAL WBB LMP CHARACTERISTICS AND MAIN PARAMETERS

This Report contains studies and relevant analysis on a range of coexistence conditions (including geographical separation and frequency separation etc.) depending on a range of agreed WBB LMP parameters (e.i.r.p., antenna height, antenna gain, emission and reception masks, etc.) covering both AAS and non-AAS scenarios for medium power base stations and only non-AAS for low power base stations. All studies assume that the location of the WBB LMP networks or base stations is known.

Two WBB LMP technologies have been considered, one based on 3GPP technical specifications and the other based on DECT-2020 NR technical specifications. The DECT-2020 NR specifications define a single set of parameters for all devices, i.e. within DECT there are no separate technical requirements for ‘base stations’ and ‘terminals/UE’ as there is in other technologies such as 3GPP. Devices within a DECT-2020 NR network may be considered as a radio device fixed terminal (RDFT) or as a radio device portable terminal (RDPT) and can dynamically change their roles depending on the network needs.

All other parameters and assumptions are provided in ECC Report 358 [1].

3.2.1 Base station power levels

For the purpose of studies, the following base station power levels for 3GPP WBB LMP were defined:

- low power with up to 31 dBm/100 MHz e.i.r.p.;
- medium power with up to 51 dBm/100 MHz e.i.r.p.

For DECT-2020 NR the maximum power level is 23 dBm e.i.r.p. It is highlighted that for DECT-2020 NR the technical specification mandates that all radio devices (respectively RDFT and RDPT) within the network shall employ transmission power control (TPC) across the range -40 dBm to 23 dBm irrespective of the radio devices role in the network.

For WBB medium power base stations, a directional sectorial antenna was assumed, and for WBB low power base stations, an omni directional antenna.

3.2.2 Terminal station power levels

Power levels for WBB LMP terminals of up to 28 dBm e.i.r.p. was considered and power control activation was applied.

For DECT-2020 NR the power level is 23 dBm e.i.r.p. and Transmitter Power Control (TPC) was applied.

3.2.3 Channel bandwidth

For studies based on 3GPP technical specifications, channel bandwidths between 10 MHz and 100 MHz were assumed.

The DECT-2020 NR specification defines various bandwidth options. For studies based on DECT-2020 NR specification, the bandwidth option of 6.912 MHz was used. The assumption is that a 6.912 MHz channel is centred in a nominal 10 MHz channel.

3.2.4 Antenna heights

For WBB medium power base stations, a range of antenna heights up to 30 m above the ground was studied. For WBB low power outdoor base stations, the basic assumption was an antenna height above ground of 10 m. For low power indoor base stations, the basic assumption was that the antennas could be located at any height within the building.

For mobile terminals, an antenna height of 1.5 meters above ground was assumed.

3.2.5 Transmitter characteristics

For studies based on 3GPP technology, emission limits (out-of-block and out-of-band) for the non-AAS WBB LMP base stations are derived from ECC Decision (11)06 [3] (3400-3800 MHz).

Table 2: Out-of-block emission limits of the WBB LMP (non-AAS) base stations providing local area network connectivity in 3800-4200 MHz, derived from ECC Decision (11)06 [3]

Frequency offset	Maximum mean e.i.r.p. density
-5 to 0 MHz offset from lower channel edge 0 to 5 MHz offset from upper channel edge	(P_{max} – 40) dBm/5 MHz e.i.r.p. per antenna
-10 to -5 MHz offset from lower channel edge 5 to 10 MHz offset from upper channel edge	(P_{max} – 43) dBm/5 MHz e.i.r.p. per antenna

Frequency offset	Maximum mean e.i.r.p. density
Out of block baseline power limit < -10 MHz offset from lower channel edge > 10 MHz offset from upper channel edge	(P_{max} – 43) dBm/5 MHz e.i.r.p. per antenna

Table 3: Out-of-band emission limits of the WBB LMP (non-AAS) base stations providing local area network connectivity in 3800-4200 MHz, derived from ECC Decision (11)06 [3]

Frequency offset	Maximum mean e.i.r.p. density
3795-3800 MHz, 4200-4205 MHz	(P_{max} – 40) dBm/5 MHz e.i.r.p. per antenna
3790-3795 MHz, 4205-4210 MHz	(P_{max} – 43) dBm/5 MHz e.i.r.p. per antenna
3760-3790 MHz, 4210-4240 MHz	(P_{max} – 43) dBm/5 MHz e.i.r.p. per antenna
Below 3760 MHz, above 4240 MHz	-2 dBm/5 MHz e.i.r.p. per antenna
Note: P_{max} is the maximum mean carrier power in dBm for the base station measured as e.i.r.p. per carrier, interpreted as per antenna	

For WBB medium power AAS base station the emission mask from ETSI TS 138 104, section 9.7.4 [13] was used.

As a result of initial studies using agreed assumptions, some studies also considered lower out-of-band emission levels below 3800 MHz for the unsynchronised scenario.

DECT-2020 NR parameters were taken from ETSI TS 103 636-2 v1.4 [4].

3.2.6 Receiver characteristics

Studies based on 3GPP technology used receiver parameters from ETSI TS 138 104.

Some studies investigated if stricter receiver blocking levels (in combination with lower out-of-band emissions) for WBB LMP base stations, as well as frequency separation could reduce the need for coordination between 3GPP WBB LMP and WBB ECS (below 3800 MHz).

DECT-2020 NR parameters were taken from ETSI TS 103 636-2 v1.4 [4].

3.2.7 Protection criteria

Uplink (UL) interference on 3GPP WBB LMP was evaluated against an interference criteria I/N = -6 dB, alternatively a 5% throughput loss criteria was studied.

Interference criteria used in studies for DECT-2020 NR was S/(N+I) = 5 dB, with S = -77 dBm.

3.2.8 Synchronisation of WBB LMP

Two WBB LMP network technologies have been considered, one based on 3GPP technical specifications and the other based on DECT-2020 NR standards. Networks using these two technologies cannot synchronise with each other due to different radio protocols. Synchronised operation of WBB LMP networks with WBB ECS below 3800 MHz is only possible for WBB LMP based on 3GPP technical specifications. The study results of these two technologies are presented separately.

3.3 COEXISTENCE SCENARIOS

A table of allocation of services and application according to ECO Frequency Information System (EFIS) for the frequency range 3400-4400 MHz is provided in ECC Report 358, table 1 [1]. An overview of the interference scenarios studied in the present document is provided in Table 4

Table 4: Overview of studied interference scenarios (interference links)

Interfering system	Victim system	Studies
Between WBB LMP		
WBB low power (outdoor)	WBB low power (outdoor)	In-band
WBB low power (indoor)	WBB low power (outdoor)	In-band
WBB low power (outdoor)	WBB low power (indoor)	In-band
WBB medium power	WBB medium power	In-band
WBB medium power	WBB low power (indoor)	In-band
WBB medium power	WBB low power (outdoor)	In-band
Between WBB LMP and WBB ECS		
WBB low power (indoor)	WBB ECS	Adjacent band
WBB low power (outdoor)	WBB ECS	Adjacent band
WBB medium power	WBB ECS	Adjacent band
WBB ECS (outdoor and indoor)	WBB low power (indoor)	Adjacent band
WBB ECS (outdoor)	WBB low power (outdoor)	Adjacent band
WBB ECS	WBB medium power	Adjacent band
Between WBB LMP and FS		
WBB low power (outdoor and indoor)	FS	In-band
WBB medium power	FS	In-band
Between WBB LMP and FSS (s-E)		
WBB low power (outdoor and indoor)	FSS (s-E)	In-band
WBB medium power	FSS (s-E)	In-band
Between WBB LMP and other applications		
WBB low power (outdoor)	VGOS (Note 1)	In-band
WBB medium power	VGOS (Note 1)	In-band
Note 1: The in-band interference scenario between WBB LMP and VLBI Global Observing System (VGOS) stations operating in few CEPT countries, is supporting EU interests as part of the European Critical Infrastructure Project Galileo.		

Studies between WBB LMP and RA were conducted in ECC Report 362 [2].

3.4 CONCLUSIONS ON COEXISTENCE WITH IN-BAND SERVICES

3.4.1 WBB LMP (3GPP)

ECC Report 358 [1] provides two studies on the coexistence between two WBB LMP networks. Considering the various types of use cases there may be various needs of UL/DL resources and different technologies. The studies are mainly based on the assumption of no synchronisation between WBB LMP networks in the frequency band 3800-4200 MHz. Indoor-only, outdoor-only and outdoor/indoor deployment scenarios have been considered. The analysis of in-band and adjacent channel operation demonstrate the feasibility of unsynchronised WBB LMP operation in the frequency band 3800-4200 MHz. However, coordination on case-by-case basis is required.

One study looked at the necessary separation distance using a protection criterion of I/N=-6 dB for a co-channel scenario, another study simulated the separation distance and the field strength values at the middle point between the networks for co-channel and adjacent channel scenarios based on the criterion that uplink throughput loss should not be exceeded by 5%, 10%, 20% and 30%.

The simulation results show that:

1. In urban/suburban areas, when WBB non-AAS low power base stations are within clutter, there is no particular separation distance observed beyond 250 m and no coordination measure is required for this situation even in co-channel in such scenarios.
2. In rural areas, when WBB non-AAS low power base stations are above clutter, the required separation distance between WBB non-AAS low power base stations in the co-channel scenario can be up to 3 km depending on the antenna height, down tilt, etc.
3. The more challenging coexistence scenario is that between WBB medium power base stations. In those cases the required separation distance can go up to 26.8 km depending on the type of antenna, antenna height, downtilt, environment, etc. The results of the studies also indicate that coexistence between co-channel WBB medium power base stations using AAS is less challenging compared to using non-AAS. The required separation distances for WBB AAS medium power base stations range up to 23 km depending on the AAS configuration, the e.i.r.p., antenna height, down tilt, environment, etc.
4. Adjacent channel operation between neighbouring WBB medium power base stations is more feasible based on the simulation results.

One of the studies also looked at the separation distance and maximum field strength values in the middle point between two WBB LMP networks for co-channel and adjacent channel scenarios, based on the criterion that uplink throughput loss should not be exceeded by 5%, 10%, 20% and 30%.

The following mean/medium field strength values (not to be exceeded) at the WBB LMP network licensed area edge were proposed to be considered for improving planning and coordination at the network licensed area border.

Table 5: Field strength values at local area network licensed area border for unsynchronised operation

Environment	WBB low power base station Urban/Suburban/Rural dBμV/m/5 MHz at 3 m height	WBB medium power base station Urban/Suburban/Rural dBμV/m/5 MHz at 3 m height
Co-channel	32	NA
Adjacent channel	48	26 for non-AAS BS 48 for AAS BS

Note: Co-channel case is defined as the case where the local area network has full or partial frequency overlap with at least one of the neighbouring local area networks. Adjacent channel case is defined as the case where the local area network has no-frequency overlap (full or partial) with any neighbouring local area networks.

Table 6: Field strength values (dBµV/m/5 MHz) at 3 m at each local area network licensed area border for synchronised operation with neighbouring local area networks (for both non-AAS and AAS BS)

Environment	Field strength value dBµV/m/5 MHz at 3 m height
Urban/Suburban/Rural	61

The above study results could be used when developing guidelines for managing coexistence between WBB LMP networks.

3.4.2 Fixed Service

ECC Report 358 [1] includes coexistence studies for scenarios to ensure protection of the fixed service (FS), including the possibility for their future evolution and development.

Studies based on agreed assumptions on WBB LMP and FS parameters, assuming flat terrain, estimated that the following separation distances to be necessary in order to protect FS links:

- in case of WBB low power base stations, studies show that maximum separation distances in the direction of the FS main lobe could range up to 56.5 km while in the side lobe maximum separation distances could be up to 300 m (clutter was assumed at the WBB LMP end of the propagation path for these values);
- in case of WBB medium power base stations, studies show that maximum separation distances in the direction of the FS main lobe could range up to 113 km while in the side lobe maximum separation distances could be up to 69 km (no clutter assumed for these values).

The mentioned separation distances depend on various factors such as clutter (which depends on the environment: rural, sub-urban, urban, indoor/outdoor), antenna pointing, antenna heights, the maximum FS antenna gain, the FS elevation angle, the feeder loss and others. In case of WBB low power indoor base station, the separation distances in the direction of the FS main lobe vary from 2.6 km to 25.5 km and they can be less than 100 m in the side lobe. These values depend on the building material and consequently on the building entry loss.

One of the studies shows the importance that real terrain data are taken into account in the coexistence assessments, because real terrain data can either hinder or favour propagation significantly. This then affects the required separation distances and areas where WBB LMP deployment needs to be excluded (exclusion areas).

In conclusion, according to the analyses, it is not possible to define generic technical conditions that guarantee the protection of FS. Instead a case-by-case analysis is needed, in combination of considering appropriate mitigation techniques, to ensure the protection of current and future deployment of FS. In addition, due to the large separation distances that may be necessary, the protection of FS cannot always be managed at national level only but may also require cross-border coordination on a case-by-case basis as well as bilateral or even multilateral agreements between neighbouring countries.

3.4.3 Fixed satellite service (space-to-earth)

The results of the various studies show that the separation distances required between WBB LMP and FSS can vary significantly depending on the assumptions taken. An overall depiction of generic studies (without terrain data) are provided below.

Considering the FSS earth station long-term protection criteria:

- WBB medium power: 36.5-47.9 km (without clutter) and 10.5-18 km (with clutter at one end of the propagation path[2]);
- WBB low power: 21.5-33.3 km (without clutter) and 2-4.7 km (with clutter at one end of the propagation path).

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[2] clutter loss applied at one end of propagation path (in the range 29-31 dB)

Considering the FSS earth station short-term protection criteria:

- WBB medium power: 273-277 km (without clutter) and 18 km (with clutter at one end of the propagation path);
- WBB low power: 90-109 km (without clutter) and 2 km (with clutter at one end of the propagation path).

Some studies show that the real terrain should be taken into account in the coexistence assessments, because it can hinder or favour propagation and then the separation distance. Resulting separation distances from those studies range in 5.3-17.2 km for WBB low power base stations and 17.5-70 km for WBB medium power base stations when considering long-term protection criterion. One study considering the real terrain and the short-term protection criteria indicated separation distances of up to 9.3 km for WBB low power BS and 35 km for WBB medium power BS for one earth station example.

Another case study using real terrain data suggests a coordination distance around an FSS earth station location of 40 km is suitable to protect FSS earth station receivers. The use of one or combination of some of the various mitigation techniques presented in that study could be implemented to minimise the interference received and reduce the required separation distance between the WBB LMP and the FSS earth station.

It is not possible to define generic technical conditions that guarantee the protection of FSS. Careful planning and case-by-case analysis is needed, in combination of considering appropriate mitigation techniques, to ensure the protection of current and future deployment of FSS. In addition, due to the large separation distances that may be necessary, the protection of FSS cannot always be managed at national level only but may also require cross-border coordination on a case-by-case basis as well as bilateral or even multilateral agreements between neighbouring countries.

3.4.4 Galileo – VGOS stations

VGOS stations operating in few CEPT countries and supporting EU interests as part of the European Critical Infrastructure Project Galileo. It is recognised that for the moment these observations, which are operating in the spectrum bands of the 2-14 GHz range, have no radio astronomy allocation in 3800-4200 MHz frequency band and therefore cannot claim interference protection at international or European level. Therefore, this Report does not include the results of the VGOS studies performed in ECC Report 358 [1]. Nevertheless, administrations are urged to take all practical steps to protect these observatory operations from harmful interference.

3.4.5 DECT-2020 NR technical sharing studies

In-band coexistence studies are based on Minimum Coupling Loss (MCL) analysis using the agreed protection criteria for each service and propagation parameters. For in-band adjacent channel analysis, Net Filter Discrimination (NFD)[3] has been used to account for the defined mask of the interfering transmitter and defined receiver filter mask.

Medium power operation is not envisaged for DECT-2020 NR, therefore only 23 dBm (assuming a 0 dBi antenna) for a channel bandwidth of 6.912 MHz (operating in the centre of the 10 MHz channel raster) was used in studies. If wider area coverage is needed by a user at their site, additional DECT-2020 NR devices can be deployed within a self-organising mesh network rather than increasing the output power (and the consequential increase in possible interference to other users).

3.4.5.1 Between DECT-2020 NR systems

DECT-2020 NR uses advanced spectrum protocols that enable local, device-based interference management through autonomous, time-accurate interference avoidance between devices in the same network, and also with devices operating in other DECT-2020 NR networks. These protocols can manage coexistence between

[3] The NFD is calculated using the method given in ETSI TR 101 854. A bandwidth correction is applied if the interfering transmitter's bandwidth is greater than that of the victim receiver. The NFD is included in the MCL as a loss on the radio interference path

networks locally and therefore the need to study DECT-to-DECT coexistence is largely inconsequential but is included for information and completeness.

The maximum separation distance needed between DECT-2020 NR deployments is 0.582 km when considering the co-channel operation with no clutter. This distance reduces to 0.250 km when assuming clutter at one terminal. Separation distances for two immediate adjacent 10 MHz channels are 30 metres.

3.4.5.2 DECT-2020 NR interfering with 3GPP WBB LMP

Two 3GPP WBB LMP bandwidths were assumed within the studies, i.e. 10 MHz and 100 MHz victim bandwidths for both WBB low and medium power 3GPP scenarios. In the co-channel case with 100 MHz 3GPP WBB LMP channels, one 6.912 MHz DECT-2020 NR interferer has been assumed to be operating in each 10 MHz (10 DECT-2020 NR in 100 MHz) to assess the effect of aggregated interference from DECT-2020 NR, which is representing the theoretical worst-case and not necessarily experienced in practice.

For co-channel, when clutter is applied separation distances of the order of 2 to 3 km are calculated. When no clutter is applied, separation distances increase to approximately 30 to 33 km. There is no discernible increase in separation distances when considering aggregation.

For adjacent channel studies, separation distances range between 1.1 and 5 km, depending on low power or medium power and their receiver bandwidths.

For shared spectrum operation DECT-2020 NR has the capability to detect interference from any other systems sharing the same or adjacent spectrum. DECT-2020 NR supports polite spectrum operation, i.e. the device senses. The spectrum uses prior its own transmission to avoid collision with other transmissions and to enable operation on least interfered channels by supporting Listen Before Talk protocol. These polite protocols would enhance spectrum sharing but have not been considered in the MCL analysis.

3.4.5.3 3GPP WBB LMP interfering with DECT-2020 NR

Studies show in the co-channel case separation distances range from 0.25 km to 3.6 km depending on assumed clutter losses and bandwidth of the interferer. In the adjacent channel case, separation distances are approximately 100 m or less.

For the 3GPP WBB LMP as the interferer and DECT-2020 NR as the victim, only the medium power (3GPP WBB) case has been modelled as the worst-case scenario. Separation distances for low power (3GPP WBB) would be less than those derived here.

3.4.5.4 Between DECT-2020 NR and FSS

The studies of DECT-2020 NR into the FSS consider both long-term and short-term interference scenarios. The effect of applying clutter at one terminal significantly reduces the required separation distances. Studies consider the DECT-2020 NR interferer at 0, 10 and 180 degrees azimuth with respect to the FSS antenna.

For long-term interference, at 0 degree azimuth, i.e. the DECT-2020 NR interferer is on the maximum FSS antenna gain with the inclination set to 10 degrees, the separation distances range from 3 to 51 km depending on the application of clutter. In the adjacent channel separation distances range between 0.6 and 15 km. Outside the main beam separation distances reduce as would be expected.

In the short-term scenario, separation distances vary between 91 km and 1.2 km in the co-channel, 0 degree azimuth case. In the adjacent channel, separation distances vary between 13 km and 0.37 km and reduce further when azimuth separation increases.

3.4.5.5 Between DECT-2020 NR and FS

The study assesses the geographical separation required when the DECT-2020 NR interfering signal is incident to the victim receiver at 0, 10 and 180 degrees azimuth. The largest separation distance for a single-entry interferer at 0 degree without clutter is 130 km. This reduces to 37 km when clutter is assumed.

In the adjacent channel case, separation distances reduce to between 81 km and 5 km depending on applying clutter. In off-axis geometries separation distances reduce significantly, for example down to 1.3 km when clutter is applied in the co-channel, 10 degrees azimuth, case.

3.4.5.6 Conclusions for DECT-2020 NR

The table below provides a summary of the co-channel MCL analysis outlined above when considering clutter at the DECT-2020 NR terminal operating with a maximum antenna height of 10 m.

Table 7: Summary of DECT-2020 NR in-band coexistence studies

Interferer	Victim	Co-channel separation distance (km)	Comment
DECT-2020 NR	DECT-2020 NR	0.250	DECT-2020 NR spectrum management functionality removes the need to consider separation distances between different DECT-2020 NR networks
DECT-2020 NR	3GPP low power WBB LMP	1.8	For 10 MHz 3GPP WBB LMP
		0.7	For 100 MHz 3GPP WBB LMP
DECT-2020 NR	3GPP medium power WBB LMP	2.7	For 10 MHz 3GPP WBB LMP
		1.0	For 100 MHz 3GPP WBB LMP
3GPP MP (only medium power considered as the worst-case)	DECT-2020 NR	0.29	For 10 MHz 3GPP WBB LMP
		0.25	For 100 MHz 3GPP WBB LMP
DECT-2020 NR	FSS	3	Long-term interference protection ratio
		1.2	Short-term interference protection ratio
DECT-2020 NR	FS	37	
Note: The e.i.r.p. of DECT-2020 NR is 23 dBm (0 dBi antenna gain)			

Studies show that the required separation distances needed between DECT-2020 NR WBB LMP and 3GPP WBB LMP networks, and between DECT-2020 NR WBB LMP networks and incumbent services demonstrate the feasibility of DECT-2020 NR WBB LMP operation in the 3800-4200 MHz frequency band. As noted above, adjacent (in frequency and/or geography) DECT-2020 NR WBB LMP networks can be locally managed autonomously by the devices themselves, removing the need for manual coordination and the requirement for a separation distance.

3.5 CONCLUSIONS ON COEXISTENCE WITH ADJACENT BAND SERVICES

3.5.1 WBB ECS below 3800 MHz

The conclusions drawn from the studies in ECC Report 358 [1] are strongly depending on the input assumptions used in the various studies.

If local or national circumstances are different from those assumptions e.g. clutter, availability of terrain information, density of existing and planned/future deployments, then different coexistence conclusions may be reached.

Considering the various types of use cases there may be various needs of UL/DL resources and different technologies. The studies are mainly based on the assumption of no synchronisation between WBB LMP networks in the frequency band 3800-4200 MHz and WBB ECS networks below 3800 MHz. Adjacent channel coexistence between 3GPP-based synchronised WBB LMP networks is considered covered by 3GPP/ETSI standardisation and thus is not studied in this Report.

The studies were performed based on two protection criteria. Some studies used the protection criterion I/N = -6 dB, while other studies used the throughput loss metric (not to be exceeded by more than 5%).

Two studies assumed minimum separation distance of 100 m.

Another study calculated required separation distance needed in order to meet protection criteria, while using more stringed Out-of-band emission requirements.

Table 8: The conclusions regarding the need for lower unwanted emissions for WBB LMP base stations to protect WBB ECS below 3800 MHz

Studies	Low and Medium Power non-AAS unwanted emissions below 3800 MHz	Medium Power AAS unwanted emissions below 3800 MHz	Study assumptions and achieved separation distance
Study 3	-45 dBm/MHz conducted power	-45 dBm/MHz t.r.p.	100 m LOS separation assumed for all cases, intra-network inter cell interference considered. The WBB LMP BS out-of-band emission level below 3800 MHz is tuned to reach the target WBB ECS BS uplink throughput loss of 5%. More stringent unwanted emission limits were found for some scenarios.
Study 6	-45 dBm/MHz conducted power	-45 dBm/MHz t.r.p.	Separation distances were calculated assuming -45 dBm/MHz conducted/t.r.p. value below 3800 MHz and I/N -6 dB protection criteria. Resulting separation distances: low power case: 95-929 m (For different scenarios) medium power case: 350-827 m (For different scenarios)
Study 7	-40 dBm/MHz e.i.r.p.	-43 dBm/5 MHz t.r.p.	100 m LOS separation between single WBB ECS and WBB LMP BS assuming urban scenario only. The WBB LMP BS out-of-band emission level below 3800 MHz is tuned to reach the target WBB ECS BS uplink throughput loss of 5%

There are 4 issues identified by the results of the studies:

- Issue 1: Possible need for lower unwanted emission levels for unsynchronised WBB LMP to protect WBB ECS below 3800 MHz;
- Issue 2: Possible need for frequency separation for unsynchronised WBB LMP to protect WBB ECS below 3800 MHz due to WBB ECS receiver blocking, in particular with WBB medium power base stations;
- Issue 3: Possible need to define better Rx blocking levels below 3800 MHz for WBB LMP BS to avoid blocking of WBB LMP base station receiver from WBB ECS transmission below 3800 MHz in case of unsynchronised operation;
- Issue 4: Possible need for defining the maximum e.i.r.p. for fixed WBB LMP terminals operating directly adjacent to the WBB ECS receive frequency.

The studies were performed based on two protection criteria. Two studies used the I/N protection criterion (i.e. I/N = -6 dB), while four studies used the throughput loss metric (i.e. uplink throughput loss not to be exceeded by more than 5%).

Some studies investigated if stricter out-of-band emission and receiver blocking levels of WBB LMP and frequency separation could reduce the need for coordination between 3GPP WBB LMP and WBB ECS (below 3800 MHz).

The following technical conditions were investigated:

- 60 MHz frequency separation for WBB medium power to accommodate WBB ECS BS receiver blocking;
- out-of-band emission level of -45 dBm/MHz conducted power or -40 dBm/MHz e.i.r.p. per sector below 3800 MHz for low power and medium power non-AAS BS;
- out-of-band emission level of -45 dBm/MHz t.r.p. or -50 dBm/MHz t.r.p. per sector for medium power AAS BS;
- WBB LMP receiver blocking level of -15 dBm below 3800 MHz for wanted signal level: P_ref_sens + 6 dB.

In addition to the above technical conditions, studies identified possible components for the coordination process to ensure the coexistence between WBB LMP and WBB ECS below 3800 MHz, e.g.:

- pfd or field strength values at the WBB LMP local area network coverage border;
- physical separation between WBB LMP and WBB ECS macro base stations;
- synchronisation or semi-synchronisation between WBB ECS and WBB LMP networks.

Studies were performed for semi-synchronised operation with DL to UL modifications (a specific sub-case of semi-synchronised operation) for WBB LMP network based on 3GPP technical specifications. Considering WBB LMP base station to WBB ECS base station interference, it can ensure the same protection of WBB ECS base stations below 3800 MHz as synchronised operation. This approach could be considered on a case-by-case basis. It could better facilitate coexistence with some limitations on UL/DL sequences on WBB LMP frame structure providing higher uplink capacity but with some possible constraints on WBB LMP uplink performance.

3.5.2 Between DECT-2020 NR and WBB ECS below 3800 MHz

Within a DECT-2020 NR network, all devices have the same technical characteristics even if they have different roles within the network, and all devices implement Transmitter Power Control (TPC) regardless of whether they are a ‘base station’ (sink node) or ‘terminal’ (router or leaf node). All messages, including beacon transmissions are adjusted to cover the 'next hop' and not to cover as wide an area as possible. Consequently, within a DECT-2020 NR network, the average radio device transmit power is much lower than the maximum transmitter output power and an average out-of-band emission level would be much lower than the specified out-of-band emission level.

One study adopted a Monte-Carlo approach to assess the risk, from a theoretical statistical basis, of interference of a single DECT device randomly placed within the service area of the WBB ECS base station (600 m cell range). No minimum geographical separation distance between WBB LMP and WBB ECS was assumed.

The study assumed outdoor operation of 6.912 MHz bandwidth DECT-2020 NR operating in the centre of the 10 MHz channel raster at 23 dBm e.i.r.p. (0 dBi antenna gain) and an urban macro WBB ECS, with a 100 MHz WBB ECS carrier centred at 3750 MHz, i.e. immediately adjacent to the 3800 MHz band edge. Transmit power of the DECT-2020 NR device with TPC active (randomly generated from the uniform distribution in the range from -40 dBm to 23 dBm).

The study showed that the probability of interference to an adjacent channel WBB ECS base station of one randomly placed transmitting DECT device is between 0.52-1.76% (depending on frequency separation) providing that TPC is used, noting that the ETSI standard requires all DECT-2020 NR devices to implement TPC. This assumes there is only one WBB ECS BS with a cell range of 600 m.

It should be noted that other assumptions, for example WBB ECS cell size or power control algorithm behaviour, would give different results on the probability of interference.

3.5.3 Fixed Satellite Service below 3800 MHz

As FSS below 3800 MHz is considered to be the same service as above 3800 MHz, the operation of FSS below 3800 MHz is covered by the in-band sharing studies in 3800-4200 MHz.

3.5.4 Radio Altimeters (RA) in 4200-4400 MHz

The studies in ECC Report 362 [2] looks at the minimum distance between an airplane and a WBB LMP base station required in order to ensure that there is no risk of harmful interference affecting the performance on the radio altimeters at an airplane landing or taking off. It was also assumed that WBB LMP base stations respect the Obstacle Limitation Surface (OLS) according to recommended practices provided by International Civil Aviation Organization (ICAO) for airport design and operations.

The studies are based on measurements for several radio altimeter models, with Interference Tolerance Thresholds (ITT) derived from published AVSI Reports[4]. The ITT of the various radio altimeter models differ by many dB. Only usage category 1 (UC1) radio altimeters have been considered as that category is “used in a wider variety of safety-critical systems that enable safe operation of commercial airliners in all-weather conditions” (as stated in AVSI Report Vol. I).

The base line studies were conducted for RA heights of 200 and 1000 feet, which corresponds to the heights for which data on the RA were provided. As a sensitivity analysis, RA heights below 200 feet was studied, where ITT values for 200 feet were assumed also for heights below 200 feet.

The main scenario was modelled as a nominal Instrument Landing System (ILS) approach with associated Obstacle Limitation Surface (OLS).

Two sets of parameters were used as the baseline for the studies:

- Parameter Set 1 contains data on a variety of radio altimeter models primarily derived from AVSI Report Volume III;
- Parameter Set 2 contains data for the least resilient radio altimeter model based on AVSI Report Volume I and Volume II.

The Parameter Sets also use different assumptions for the radio altimeter antenna.

Based on the above radio altimeter parameters, as well as typical base station parameters with antenna main beams pointing at or below the horizon, this Report derives the following conclusions for the modelled ILS approach scenario:

For the frequency band 3800-4100 MHz:

- All studies show sufficient margins for unwanted emissions and radio altimeter blocking covering at least the 6 dB safety margin as recommended by International Civil Aviation Organization (ICAO;

For the frequency band 4100-4200 MHz:

- For non-AAS WBB LMP base stations, all studies show sufficient margins for unwanted emissions and Radio Altimeter blocking covering at least the 6 dB ICAO safety margin;
- For AAS WBB LMP base stations:
    - the 6 dB ICAO safety margin is always met when considering radio altimeter blocking (WBB LMP AAS in-band emissions);
    - Studies of radio altimeter protection at 200 and 1000 feet (baseline) show sufficient margins for unwanted emissions and radio altimeter blocking covering at least the 6 dB ICAO safety margin;
    - A study which applies the 200 feet ITT values below 200 feet (sensitivity analysis) shows that for unwanted emissions from WBB LMP falling in the 4200-4400 MHz band, base stations that were modelled with 4x4 and 8x8 AAS (non-sub-array) configurations close to the runway threshold can lead to situations where the 6 dB ICAO safety margin is not met by 13 dB (assuming the Block Edge Mask derived from ETSI TS 138 104 [12]). The same study shows the 6 dB safety margin is fully covered for BS positions greater than 1200 m from the runway threshold or 40 m laterally, or at all BS positions with emission levels, between 4200-4240 MHz, equal to the spurious emission limit.

[4] Aerospace Vehicle Systems Institute (AVSI) is an aerospace industry research cooperative that facilitates collaborative research and technology projects for its members. The referenced reports can be found at https://avsi.aero.

4 PROPOSED HARMONISED LEAST RESTRICTIVE TECHNICAL CONDITIONS

CEPT proposes that Member States designate the frequency band 3800-4200 MHz, or parts of this band, on a non-exclusive basis for low/medium power of terrestrial wireless broadband systems (WBB LMP) providing local-area network connectivity. The Member States also need to ensure the protection of the current and future evolution and development of the incumbent services in the 3800-4200 MHz frequency band (FSS receiving earth stations and FS links) as well as in the adjacent bands (WBB ECS in 3400-3800 MHz frequency band and radio altimeters on board aircraft in 4200-4400 MHz as well as FSS receiving earth stations and FS links below 3800 MHz). The use of WBB LMP in the 3800-4200 MHz frequency band for connectivity to aerial terminal stations was not studied, therefore administrations may restrict the use of WBB LMP aerial terminal stations.

The proposed harmonised technical conditions are presented in Annex 1. They are based on the results of the technical studies in ECC Report 358 [1] and ECC Report 362 [2]. The proposed harmonised technical conditions for WBB LMP have been developed assuming an authorisation regime where the location of WBB LMP networks or base stations is known. An authorisation regime where the location is not known is out of scope for the harmonisation proposed in this Report as this situation may create a risk of interference for existing and new WBB ECS base stations below 3800 MHz, fixed links and FSS earth stations as well as between WBB LMP networks.

These conditions include maximum in-block e.i.r.p. limits for WBB low power and medium power base stations, in view of ensuring protection, taking into account the long-term development of incumbent users sharing the 3800-4200 MHz frequency band, in particular receiving satellite earth stations and terrestrial fixed links. See also section 5 on the management of local exceptions.

It has not been possible to define generic technical conditions that alone guarantee the protection of all incumbent services in the band (FSS receiving earth stations and FS links), and adjacent bands (WBB ECS, FSS receiving earth stations and FS links). Careful planning and case-by-case analysis is needed, in combination of considering appropriate mitigation techniques.

National coordination may also be needed in order to ensure the protection of the radio altimeters above 4200 MHz from medium power AAS base stations that are located in close proximity to an airport and operating in 4100-4200 MHz.

The harmonised technical conditions presented in this Report are defined to respect technology neutrality for the operation of WBB LMP.

For the purpose of this CEPT Report, a base station is a fixed radio device providing the gateway between the back-end network, for example the gateway to the internet or the user's fixed infrastructure, and the WBB LMP user devices/terminals.

5 THE MANAGEMENT OF LOCAL EXCEPTIONS BY NATIONAL ADMINISTRATIONS

With respect to in-block base station power, e.i.r.p. limits are defined for WBB low power and medium power base station as part of the harmonised technical conditions. This does not preclude local exceptions to be considered by national administrations in specific circumstances under the following conditions:

- it shall be on a case-by-case basis in exceptional cases;
- it shall remain a local area coverage (no nationwide network);
- protection of incumbent services (FSS receiving earth stations and FS) is ensured within the band where appropriate, taking into account their future development, as well as in adjacent bands, including in the neighbouring countries;
- coordination is completed if required.

6 CONCLUSIONS

In this Report, the technical feasibility of the shared use of the 3800-4200 MHz frequency band by low/medium power terrestrial wireless broadband systems (WBB LMP) providing local-area network connectivity was assessed, in line with the objective of the EC Mandate.

CEPT noted that a few CEPT countries have already taken national initiatives in the 3800-4200 MHz frequency band, as well as in parts of the 3400-3800 MHz frequency band, to respond to specific local/vertical market demands that may not be met in the frequency bands that have already been harmonised for 5G ECS.

The 400 MHz available in the 3800-4200 MHz frequency band can enable the deployment of terrestrial wireless broadband systems to provide local area connectivity for a variety of services. For the various types of use cases there may be various needs of UL/DL resources and different technologies, resulting in unsynchronised operation. The wide range of local use cases, used across different industrial and non-industrial environments both indoors and outdoors, will benefit from harmonised technical conditions.

CEPT studies in ECC Report 358 [1] and ECC Report 362 [2] have considered the compatibility with and protection of all incumbent services, including their future deployments, within the band and in adjacent frequency bands.

6.1 WBB LMP MAIN CHARACTERISTICS AND ASSUMPTIONS

Studies and analysis have considered a range of agreed WBB LMP parameters (e.i.r.p., antenna height, antenna gain, emission and reception masks, etc.) covering both AAS and non-AAS scenarios for medium power base stations, but only non-AAS for low power base stations. Two WBB LMP technologies have been considered, one based on 3GPP technology and the other based on DECT-2020 NR. All studies assume an authorisation regime where the location of the WBB LMP networks or base stations is known.

For the purpose of studies, the following base station power levels for 3GPP WBB LMP were defined:

- low power with up to 31 dBm/100 MHz e.i.r.p.;
- medium power with up to 51 dBm/100 MHz e.i.r.p.

These power levels are also proposed to be a part of the harmonised technical conditions.

For studies relating to DECT-2020 NR, the maximum e.i.r.p. of 23 dBm was assumed in a channel bandwidth of 6.912 MHz.

For studies based on 3GPP technology, the technical characteristics were based on current ETSI technical specifications. DECT-2020 NR parameters were taken from ETSI TS 103 636-2 v1.4 [4].

6.2 COEXISTENCE WITH FIXED SATELLITE SERVICE (FSS)

Fixed satellite service (FSS) is a primary user of the 3800-4200 MHz frequency range in Europe. With the introduction of 5G in the 3400-3800 MHz frequency band in Europe, many FSS stations which operated below 3800 MHz have migrated to the 3800-4200 MHz frequency band. The 3800-4200 MHz frequency band is crucial for FSS due to its unique characteristics, including wide geographic coverage over continents and resistance to rain fade. A limited number of FSS earth stations have been maintained in the frequency band below 3800 MHz, since this is the same service as above 3800 MHz, feasibility of FSS below 3800 MHz is considered to be covered by the conclusions of in-band FSS. CEPT studies assumed that the location of FSS receiving earth stations is known.

The results of the various studies show that the separation distances required between WBB LMP and FSS can vary significantly depending on the assumptions taken. Studies were performed with and without clutter loss (signal strength being blocked by nearby obstacles such as buildings) at either site of the path. Two FSS protection criteria were also considered, a long-term criterion as well as a short-term criterion resulting in considerably larger separation distances.

When using the long-term protection criterion, the generic studies (without terrain data) show separation distances up to 48 km for WBB medium power and 33 km for WBB low power. When clutter loss at one end of the propagation path is assumed, the corresponding distances are up to 18 km (medium power) and 4.7 km (low power). Studies using real terrain data show separation distances in the range of 5.3-17.2 km for WBB low power and 17.5-70 km for WBB medium power stations. Results for DECT-2020 NR are consistent with the low power separation distances noted above when a transmitter power of 23 dBm is considered (i.e. 3 km for the long-term protection criterion with clutter applied at one end of the propagation path).

When the result is evaluated against the short-term protection criterion, the protection distance was found to be up to 277 km (medium power, flat terrain, and no clutter loss assumed). A case study on one specific earth station indicated separation distances of up to 9.3 km for WBB low power and 35 km for WBB medium power stations.

In conclusion, it is not possible to define generic technical conditions that guarantee the protection of FSS. To ensure the protection of current and future deployment of FSS, careful planning and case-by-case analysis is needed, also in considering appropriate mitigation techniques. In addition, due to the large separation distances that may be necessary, the protection of FSS within the frequency band as well as below 3800 MHz cannot always be managed at national level only, but may also require cross-border coordination on a case-by-case basis as well as bilateral or even multilateral agreements between neighbouring countries.

CEPT intends to develop guidelines in order to help administrations to address coordination and planning both at national level and with the neighbouring countries.

6.3 COEXISTENCE WITH FIXED SERVICE (FS)

Fixed service (FS) is a primary user of the 3800-4200 MHz frequency range in Europe including both military and civil usages. Civil use is primarily fixed point-to-point microwave links connecting different points in a network, such as data centres or remote locations. Military usage includes fixed microwave links that support military communications and surveillance systems. CEPT studies assumed that the locations of FS stations are known.

In 2023 a questionnaire on the current and planned use of the frequency band 3800-4200 MHz in Europe has been submitted to the CEPT administrations. A total of 14 CEPT countries have reported civil FS usage in the 3800-4200 MHz frequency band, primarily fixed point-to-point microwave links. One country reported significant usage with approximately 400 point-to-point links, while the other 13 countries have reported between approximately 2 and 120 point-to-point links. Some administrations plan to continue using the band for fixed links, as well as possible new ones, since the migration to higher bands with different propagation characteristics would be very costly.

For WBB medium power base stations, studies assuming flat terrain indicate that required separation distances in the direction of the FS main lobe could range up to 113 km. In flat terrain if the WBB medium power base station site is in the side lobe of the receiving FS antenna, the required separation distance will be shorter (up to 69 km). For WBB low power base stations, studies assuming flat terrain indicate that required separations distances in the direction of the FS main lobe could range up to 46.3 km. In this case clutter is applied to the WBB side for the low power base station as the maximum antenna height is limited to 10 m. For DECT-2020 NR, when using comparable assumptions to WBB low power base station case, the required separation distance is 37 km. Case studies performed show the importance to consider real terrain data, because real terrain can either hinder or favour propagation significantly. This then affects the required separation distances and areas where WBB LMP deployment needs to be excluded (exclusion areas).

In conclusion, it is not possible to define generic technical conditions that guarantee the protection of FS. Careful planning and case-by-case analysis is needed, in combination of considering appropriate mitigation techniques, to ensure the protection of current and future deployment of FS. In addition, due to the large separation distances that may be necessary, the protection of FS cannot always be managed at national level only, but may also require cross-border coordination on a case-by-case basis as well as bilateral or even multilateral agreements between neighbouring countries.

CEPT intends to develop guidelines in order to help administrations to address coordination and planning both at national level and with the neighbouring countries.

6.4 COEXISTENCE WITH WBB ECS BELOW 3800 MHZ

The 3400-3800 MHz band has been harmonised for WBB ECS in CEPT under ECC Decision (11)06 [3] and in the EU under Decision 2008/411/EC as amended [5] and is recognised to be the 5G primary band in Europe. It is crucial that the WBB ECS service is adequately protected.

In order to manage coordination with WBB ECS below 3800 MHz, administrations may consider for example synchronisation where possible (noting some foreseen WBB LMP technology could not be synchronised with WBB ECS), pfd limits, separation distance and/or frequency separation requirements, etc.

For the various types of local use cases, there may be various needs of UL/DL resources and/or different technologies. The studies are mainly based on the assumption of no synchronisation between WBB LMP networks in the frequency band 3800-4200 MHz and WBB ECS below 3800 MHz. Adjacent channel coexistence between 3GPP-based synchronised WBB LMP networks and WBB ECS is considered as being covered by ETSI technical specifications and thus is not studied in this Report.

CEPT plans to develop recommendations for administrations to provide guidance on the protection approach for the coexistence with WBB ECS below 3800 MHz. There may be also a need to develop relevant cross-border recommendations.

6.5 COEXISTENCE WITH RADIO ALTIMETERS ABOVE 4200 MHZ

The frequency band 4200-4400 MHz is globally allocated to the aeronautical radio navigation service (ARNS), and the band is used by radio altimeters installed on board aircrafts. Radio altimeters provide precise height measurements critical for various safety functions in aviation, including automated landing.

Coexistence with radio altimeters above 4200 MHz is covered in ECC Report 362 [2]. The base line studies were conducted for RA heights of 200 and 1000 feet, which corresponds to the heights for which data on the RA were provided. As a sensitivity analysis, RA heights below 200 feet was studied, where ITT values for 200 feet were assumed also for heights below 200 feet.

The main scenario was modelled as a nominal Instrument Landing System (ILS) approach with associated Obstacle Limitation Surface (OLS).

Two sets of parameters were used as the baseline for the studies:

- Parameter Set 1 contains data on a variety of radio altimeter models primarily derived from AVSI Report Volume III;
- Parameter Set 2 contains data for the least resilient radio altimeter model based on AVSI Report Volume I and Volume II.

The Parameter Sets also use different assumptions for the radio altimeter antenna.

Based on the above radio altimeter parameters, as well as typical base station parameters and set up, ECC Report 362 derived the following conclusions for the modelled ILS approach scenario:

- Studies using Parameter Set 1 or Set 2 at 200 and 1000 feet show sufficient margins covering at least the 6 dB safety margin;
- A study using Parameter Set 2 which apply the 200 feet interference tolerance threshold below 200 feet show that unwanted emissions from base stations operating in 4100-4200 MHz band do not meet the 6 dB safety margin for the modelled beamforming antenna configurations. The same study shows the 6 dB safety margin is fully covered for BS positions greater than 1200 m from the runway threshold or 40 m laterally or with some improved out of band emission levels (Further details are provided in ECC Report 362, annex 3).

There are a number of differences between these results for Parameter Set 1 and 2 However, all studies found that lower heights are more critical than the 1000 feet Radio Altimeter when considering potential interference. In addition, results are particularly sensitive to the assumptions for the Radio Altimeter antenna patterns particularly at high off-axis angles for low heights (below 200 feet).

6.6 COEXISTENCE BETWEEN WBB LMP NETWORKS

Studies have been performed in order to evaluate the coexistence between two WBB LMP networks in the 3800-4200 MHz frequency band. For the various types of local use cases there may be various needs of UL/DL resources and/or different technologies. The studies are mainly based on the assumption of no synchronisation between WBB LMP networks. Indoor-only, outdoor-only and outdoor/indoor deployment scenarios have been considered.

Adjacent channel coexistence between 3GPP-based synchronised WBB LMP networks is considered as being covered by ETSI technical specifications and thus is not studied in this Report.

CEPT plans to develop recommendations for administrations to provide guidance on the coordination approach for the coexistence between WBB LMP local area networks.

6.7 HARMONISED TECHNICAL CONDITIONS

The proposed harmonised technical conditions in this Report are based on the results of the technical studies in ECC Report 358 [1] and in ECC Report 362 [2]. ECC Report 358 concluded that it was not possible to identify a generic set of least restrictive technical conditions that will fit every deployment scenario for shared access in all cases due to a number of factors, such as existing incumbent services and different terrain across CEPT countries.

CEPT has achieved a balance between how much coordination an administration is able to carry out between WBB LMP networks and incumbent services, and how restrictive the harmonised technical conditions on WBB LMP need to be.

The proposed harmonised technical conditions for WBB LMP have been developed assuming an authorisation regime where the location of WBB LMP networks or base stations is known. An authorisation regime where the location is not known is out of scope for the harmonisation proposed in this Report as this situation may create a risk of interference for existing and new WBB ECS base stations below 3800 MHz, fixed links and FSS earth stations as well as between WBB LMP networks.

These conditions include maximum in-block e.i.r.p. limits for WBB low power and medium power base station, in view of ensuring protection, taking into account the long-term development of incumbent users sharing the 3800-4200 MHz frequency band, in particular receiving satellite earth stations and terrestrial fixed links. This does not preclude however local exceptions outside the harmonised technical conditions to be considered by national administrations in specific circumstances, under conditions which are presented in section 5 of this Report. The harmonised technical conditions presented are defined to respect technology neutrality for the operation of WBB LMP.

It has not been possible to define generic technical conditions that alone guarantee the protection of all incumbent services. Careful planning and case-by-case analysis is needed, in combination of considering appropriate mitigation techniques.

In order to facilitate and maximise the opportunities for the deployment of WBB LMP and to manage remaining coordination cases that may not be addressed by the harmonised technical conditions, administrations may want to complement certain aspects of their use of the frequency band 3800-4200 MHz at the national and/or the local level circumstances, for example with synchronisation, pfd limits, separation distance and/or frequency separation requirements. CEPT intends to develop relevant recommendations in order to provide guidelines to administrations as appropriate.

Finally, CEPT supports the current bilateral cross-border coordination process between CEPT countries and will consider the need to develop ECC Recommendations relevant for the 3800-4200 MHz frequency band.

ANNEX 1: FREQUENCY ARRANGEMENT AND HARMONISED LEAST RESTRICTIVE TECHNICAL CONDITIONS FOR SHARED ACCESS OF WBB LMP IN 3800-4200 MHz

The harmonised technical conditions defined in this annex have been developed assuming that the location of WBB LMP networks or base stations is known, and that the protection of MFCN below 3.8 GHz, is ensured at national level with appropriate coordination.

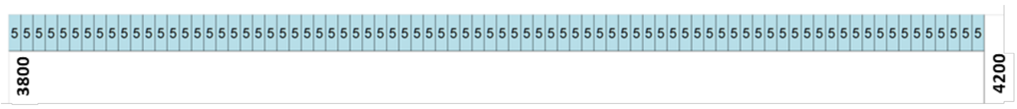
National and potentially cross-border coordination may be needed to manage coexistence with other WBB LMP networks within the 3.8-4.2 GHz frequency band.

National and/or cross-border coordination may be needed to protect the incumbent FSS receiving earth stations and FS.

A1.1 FREQUENCY ARRANGEMENT FOR THE 3800-4200 MHz FREQUENCY BAND

The frequency arrangement provided in Figure 1 is a TDD arrangement, based on a block size of 5 MHz starting at the lower edge of the frequency band at 3800 MHz. Multiple adjacent blocks of 5 MHz can be combined to obtain wider channels.

Figure 1: 3800-4200 MHz frequency arrangement



A1.2 AAS AND NON-AAS BASE STATIONS

AAS (active antenna systems) refers to a WBB LMP base station and antenna system where the amplitude and/or phase between antenna elements is continually adjusted resulting in an antenna pattern that varies in response to short term changes in the radio environment. This is intended to exclude long term beam shaping such as fixed electrical down tilt.

Non-AAS (non-active antenna systems) refers to WBB LMP base station transmitters which uses a passive antenna with a fixed antenna pattern. It may be possible to apply long term electrical beam steering to non-AAS, but non-AAS cannot respond to short term changes in the radio environment.

A1.3 WBB LMP BASE STATION IN-BLOCK POWER

Table 1 defines the maximum in-block e.i.r.p. per cell for base stations operating in the 3.8-4.2 GHz frequency band.

Table 1: Maximum in-block e.i.r.p. per cell for base stations operating in 3800-4200 MHz

Category	e.i.r.p. per cell (Note1 and Note 2)
Low power base station	≤ 24 dBm/channel for BW ≤ 20 MHz ≤ 18 dBm/5 MHz for BW > 20 MHz
Medium power base station	≤ 44 dBm/channel for BW ≤ 20 MHz ≤ 38 dBm/5 MHz for BW > 20 MHz
Note 1: In a multi-sector site, the value per 'cell' corresponds to the value for one of the sectors. Note 2: Higher e.i.r.p. levels may be authorised by national administrations in exceptional and duly justified cases, provided that protection of FSS receiving earth stations and FS links (where appropriate nationally) in the band as well as MFCN below 3.8 GHz and radio altimeters above 4.2 GHz is ensured, taking into account their future development, including in the neighbouring countries. Coverage shall remain local, i.e. no nationwide networks.	

To protect MFCN operating below 3.8 GHz, coordination may be required at national level[5].

A1.4 WBB LMP BASE STATION UNWANTED EMISSIONS ABOVE 4200 MHz

Table 2 defines the maximum unwanted emission levels above 4.2 GHz. These levels will provide a general protection of radio altimeters operating above 4.2 GHz. For AAS medium power base station in 4.1-4.2 GHz deployed in close proximity to those airports which support precision approach procedures, coordination may be needed[6].

Table 2: Maximum unwanted emission levels above 4200 MHz for WBB LMP base stations

Frequency range	Non-AAS base station e.i.r.p. limit dBm/5 MHz per cell (Note 1)	AAS MP base station t.r.p. limit dBm/5 MHz per cell
4200-4205 MHz	11	1
4205-4240 MHz	8	-3
Note 1: In a multi-sector site, the value per 'cell' corresponds to the value for one of the sectors.		

The spurious domain in these technical conditions for a base station operating in 3.8-4.2 GHz starts 40 MHz from the band edge and the corresponding spurious emission limits are defined in ERC Recommendation 74-01 [7].

A1.5 WBB LMP TERMINAL IN-BLOCK REQUIREMENTS

- Maximum terminal station power: 28 dBm t.r.p. (including a 2 dB tolerance);
- For fixed terminals an in-block e.i.r.p. limit may be defined at national level, provided that protection of in-band and adjacent band incumbent services and cross-border obligations are fulfilled;
- Transmission power control is mandatory and shall be activated.

[5] Examples of coordination may include geographical/frequency separation, defining a maximum allowed power level (pfd) at the border of the WBB LMP licensed area, synchronised operation, specific sub-cases of semi-synchronised operation which only allow DL to UL modifications to the WBB LMP network compared to the frame structure of the MFCN and/or defining the maximum unwanted emissions below 3.8 GHz depending on location of WBB LMP in relation to MFCN.

[6] Examples of coordination may include no AAS medium power base station deployment closer than 1200 m from the runway threshold and 40 m laterally from the edge of the runway, or AAS medium power base stations in compliance with emission levels meeting the spurious emission limit between 4200 and 4240 MHz.

ANNEX 2: CEPT MANDATE

Ref. Ares(2021)7794710 - 16/12/2021

MANDATE TO CEPT
ON TECHNICAL CONDITIONS REGARDING THE SHARED USE OF THE 3.8-4.2 GHZ FREQUENCY BAND FOR TERRESTRIAL WIRELESS BROADBAND SYSTEMS PROVIDING LOCAL-AREA NETWORK CONNECTIVITY IN THE UNION

1. PURPOSE

The Commission Communication on Connectivity[1] for a competitive digital single market, towards a European gigabit society updated with the Commission Communication "2030 Digital Compass: the European way for the Digital Decade"[2], set out ambitious connectivity objectives for the Union to be achieved through the widespread deployment and take-up of very high capacity networks, including 5G. The Commission Communication '5G for Europe: an Action Plan'[3] highlighted 5G as a key enabler of the digitalisation of "vertical industries" (such as transport, logistics, automotive, health, energy, smart factories, media and entertainment). It also identified a need for coordinated action at Union level, including the identification and harmonisation of spectrum for 5G to serve innovative business models and solutions for locally licensed access to spectrum. The RSPG recognised that there is a specific demand for mid-band spectrum and recommended that Member States investigate the possible use of the band 3.8-4.2 GHz for local vertical applications (i.e. low/medium power) while protecting receiving satellite earth stations and other existing applications and services.

In addition, the Commission Communication on 'A New Industrial Strategy for Europe'[4], which lays out the vision for the industrial transformation in the Union for the next 10 years stresses the importance of strengthening the digital single market to underpin the Union's digital transition. It calls on the Union to speed up investments in 5G as a major enabler for future digital services, thus setting it at the heart of the industrial data wave.

This mandate invites CEPT to assess the technical feasibility of the shared use of the 3.8-4.2 GHz frequency band by terrestrial wireless broadband systems providing local-area network connectivity with focus on vertical users and other terrestrial wireless use cases and, on that basis, deliver harmonised technical conditions for the shared use of the band. Those harmonised technical conditions should in particular ensure the protection and the possibility of future evolution and development of incumbent spectrum users in this band (notably receiving satellite earth stations in the fixed satellite service and terrestrial fixed links) and the coexistence with spectrum users in adjacent bands (such as radio altimeters on board aircraft operating in the 4.2-4.4 GHz frequency band).

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1 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 'Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society' COM(2016) 587 final.

2 COM(2021) 118 final.

3 Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions '5G for Europe: An Action Plan', COM(2016) 588 final.

4 Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions 'A New Industrial Strategy for Europe', COM(2020) 102 final.

2. POLICY CONTEXT AND INPUTS

The RSPG has developed three Opinions (November 2016[5], January 2018[6] and January 2019[7]) on a strategic spectrum roadmap towards 5G for Europe, in which it had identified 5G pioneer bands and addressed implementation challenges for 5G. In particular in its third opinion, the RSPG concludes that connectivity for vertical industries ('verticals') could be provided by mobile operator's solutions, third-party providers and directly by verticals themselves in EU-harmonised bands for electronic communications services or in dedicated spectrum for verticals. The RSPG recommends that Member States also consider other spectrum solutions including dedicated or shared spectrum for the business/sectoral needs ('verticals needs') that may not be met by mobile operators. This is also confirmed by the RSPG's Opinion of 16 June 2021[8] 'on a radio spectrum policy programme'.

In its recent Opinion of 16 June 2021[9] 'the RSPG recommends to study the possible use of the 3.8-4.2 GHz frequency band for local vertical applications (i.e. low /medium power), while protecting receiving satellite earth stations, as well as other existing radio applications and services.

Furthermore, in its Opinion of 16 June 2021[10] 'on spectrum sharing – pioneer initiatives and bands', the RSPG *inter alia* urges Member States to promote studies on sharing approaches and technologies that would lead to increased possibilities of sharing or co-existence solutions and to encourage CEPT and ETSI[11] to cooperate in support of this policy.

At present, a number of industrial sectors are looking at 5G as an enabler of the fourth industrial revolution (Industry 4.0). The deployment of reliable and resilient wireless local-area connectivity is increasingly becoming a necessity for business-critical industrial processes, such as related to automated manufacturing in smart factories, which has also been highlighted by ICT companies[12]. Due to different national circumstances e.g. priorities for efficient spectrum use, Member States have addressed demand for locally licensed access to spectrum in mid-bands in a dissimilar way.

The potential deployment of terrestrial wireless broadband systems providing local-area network connectivity (with base stations operating at low/medium power) for vertical and possibly other terrestrial wireless use cases[13] within the 3.8-4.2 GHz frequency band in the Union, subject to an authorisation decision at Member State level, requires harmonised technical conditions. This promotes ecosystem development and efficient spectrum use. It would also foster the development of innovative sharing conditions in the 3.8-4.2 GHz frequency band between terrestrial wireless broadband systems providing local-area network connectivity and the incumbent users in need of protection and the possibility of future evolution and development.

5 Document RSPG16-032 final of 9 November 2016, *Strategic roadmap towards 5G for Europe: RSPG opinion on spectrum-related aspects for next-generation wireless systems (5G) (RSPG 1st opinion on 5G).*

6 Document RSPG18-005 final of 30 January 2018, *Strategic spectrum roadmap towards 5G for Europe: RSPG opinion on 5G networks (RSPG 2nd opinion on 5G).*

7 Document RSPG19-007 final of 30 January 2019, *Strategic spectrum roadmap towards 5G for Europe: RSPG opinion on 5G implementation challenges (RSPG 3rd opinion on 5G).*

8 Document RSPG21-033 final of 16 June 2021, *RSPG Opinion on a Radio Spectrum Policy Programme (RSPP).*

9 Document RSPG21-024 final of 16 June 2021, *RSPG opinion on additional spectrum needs and guidance on the fast rollout of future wireless broadband networks.*

10 Document RSPG21-022 final of 16 June 2021, *RSPG opinion on spectrum sharing – pioneer initiatives and bands.*

11 European Telecommunications Standardisation Institute

12 https://5g-ppp.eu/wp-content/uploads/2020/09/5GPPP-VerticalsWhitePaper-2020-Final.pdf

13 Wireless local-area connectivity could serve both private (e.g. enterprise) and public (e.g. community-type) networks, which could be subject to an authorisation decision at Member State level.

In addition, any possible usage of the frequency band 3.8-4.2 GHz in combination with spectrum resources in other bands may be further assessed in a second stage taken into account the results of this mandate.

3. JUSTIFICATION

Pursuant to Article 4(2) of the Radio Spectrum Decision14, the Commission may issue mandates to the CEPT for the development of technical implementing measures with a view to ensuring harmonised technical conditions for the availability and efficient use of radio spectrum necessary for the functioning of the internal market. Such mandates shall set the task to be performed and their timetable.

The results of this Mandate should facilitate the deployment of terrestrial wireless broadband systems providing local-area network connectivity. These should support innovation and digital industrial transformation. In recognition of existing services within the 3.8-4.2 GHz frequency band other than terrestrial wireless broadband, particular attention should be paid to ensuring the protection and the possibility of future evolution and development of receiving earth satellite stations and terrestrial fixed links. Furthermore, the coexistence with terrestrial systems providing wireless broadband electronic communications services and radio altimeters operating in adjacent bands should also be duly addressed.

4. TASK ORDER AND SCHEDULE

The CEPT is herewith mandated to study the feasibility of using the 3.8-4.2 GHz frequency band by terrestrial wireless broadband systems providing local-area network connectivity in a shared manner and to develop, if feasible, relevant harmonised technical conditions therefor, which are suitable for 5G technology and protect as well as ensure the possibility of future evolution and development of incumbent spectrum users within the band and in adjacent bands.

The CEPT shall, where relevant, take full account of EU law applicable and support the principles of service and technological neutrality, non-discrimination and proportionality insofar as technically possible.

The CEPT is requested to collaborate actively with all concerned stakeholders and ETSI, which develops harmonised standards for the presumption of conformity under the Radio Equipment Directive 2014/53/EU. In particular, the CEPT should take into consideration ETSI standards, which define 5G systems and facilitate shared spectrum use[15].

Specifically, CEPT is mandated to perform the following tasks:

1. Study and assess the technical feasibility of the **shared use** of the 3.8-4.2 GHz frequency band by terrestrial wireless broadband systems providing local-area (i.e. low/medium power) network connectivity. In this regard, consider sharing solutions, including innovative features, which ensure:

    i. protection and the future evolution and development of incumbent users sharing this band, in particular receiving satellite earth stations and terrestrial fixed links;

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14 Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, OJL 108 of 24.4.2002.

15 Such as on Licensed Shared Access.

ii. co-existence of terrestrial wireless broadband systems providing local-area network connectivity and uses operating in adjacent bands such as terrestrial systems providing wireless broadband electronic communications services in the 3.4-3.8 GHz frequency band16 and radio altimeters on board aircraft in the 4.2-4.4 GHz frequency band.

2. Subject to the sharing solutions and the results of Task 1, as appropriate, develop a harmonised frequency arrangement as well as the least restrictive harmonised technical conditions for the **shared** use of the 3.8-4.2 GHz frequency band by terrestrial wireless broadband systems providing local-area connectivity. These harmonised technical conditions shall avoid interference, protect relevant incumbent uses within the band and in adjacent bands, and facilitate cross-border coordination.

Based on the results of sharing studies within the 3.8-4.2 GHz frequency band and co-existence studies with uses in adjacent bands, the CEPT may include, where necessary, guidance on appropriate receiver characteristics for radio equipment as part of the harmonised technical conditions or/and recommend to ETSI to consider the results of those studies when developing relevant harmonised standards.

In performing the aforementioned tasks, the CEPT shall allow to the greatest extent possible channelling arrangements and effective coordination with other existing systems and services to accommodate national circumstances and market demand, and the guidance provided by the Commission in consultation with the Radio Spectrum Committee.

CEPT should provide deliverables according to the following schedule:

Delivery date	Deliverable	Subject
November 2022	Interim Report from CEPT to the Commission	Description of work undertaken and interim results under this Mandate.
July 2023[17]	Final Draft Report from CEPT to the Commission	Description of work undertaken and final results under this Mandate
March 2024	Final Report from CEPT to the Commission, taking into account the outcome of the public consultation	Description of work undertaken and final results under this Mandate, taking into account the results of the public consultation

In addition, the CEPT is requested to report on the progress of its work pursuant to this Mandate to all the meetings of the Radio Spectrum Committee that will be taking place during the course of the Mandate.

The Commission, with the assistance of the Radio Spectrum Committee may consider applying the results of this mandate in the Union, pursuant to Article 4 of the Radio Spectrum Decision.

16 In particular as a primary (pioneer) 5G frequency band in the European Union.

17 Subject to subsequent public consultation

ANNEX 3: LIST OF REFERENCES

[1] ECC Report 358: "In-band and adjacent bands sharing studies to assess the feasibility of the shared use of the 3.8-4.2 GHz frequency band by terrestrial wireless broadband systems providing local-area (i.e. low/medium power) network connectivity", approved June 2024

[2] ECC Report 362: "Compatibility between mobile or fixed communications networks (MFCN) operating in 3400-3800 MHz and wireless broadband systems in low/medium power (WBB LMP) operating in the frequency band 3800-4200 MHz with Radio Altimeters (RA) operating in 4200-4400 MHz", approved November 2024

[3] ECC Decision (11)06: "Harmonised frequency arrangements and least restrictive technical conditions (LRTC) for mobile/fixed communications networks (MFCN) operating in the band 3400-3800 MHz", latest amended October 2018

[4] ETSI TS 103 636-2 v1.4: "DECT-2020 New Radio (NR); Part 2: Radio reception and transmission requirements"

[5] Decision (EU) 2019/235: "Commission Implementing Decision (EU) 2019/235 of 24 January 2019 on amending Decision 2008/411/EC as regards an update of relevant technical conditions applicable to the 3400-3800 MHz frequency band"

[6] ERC Recommendation 12-08: "Harmonised radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3600 MHz to 4200 MHz", approved 1997 and latest amended May 2024

[7] ECC Report 173: "Fixed Service in Europe Current use and future trends post 2022", approved March 2012 and latest amended June 2023

[8] ITU-R Recommendation F.382: "Radio-frequency channel arrangements for fixed wireless systems operating in the 2 and 4 GHz bands"

[9] Report ITU-R RA.2507: "Technical and operational characteristics of the existing and planned Geodetic Very Long Baseline Interferometry"

[10] Commission Decision 2008/411/EC: "Commission Decision of 21 May 2008 on the harmonisation of the 3400-3800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community"

[11] ECO Report 03: "The Licensing of "Mobile Bands" in CEPT"

[12] 3GPP TS 38.104: "5G; NR; Base Station (BS) radio transmission and reception" (version 16.18.0)

[13] ERC Recommendation 74-01: "Unwanted emissions in the spurious domain", approved 1998 and latest corrected May 2022