CEPT Report 76

Report from CEPT to the European Commission in response to the Mandate on spectrum for the future railway mobile communications system

Report B: EU-harmonised technical conditions for the future railway mobile radio communications system (Task 5)

Report approved on 20 November 2020 by the ECC

0 EXECUTIVE SUMMARY

The present CEPT Report answers task 5 of the Mandate from the European Commission to CEPT on spectrum for the future railway mobile communications system (FRMCS)[1].

Only non-AAS FRMCS has been considered. Additional studies should be performed in case AAS are considered for FRMCS deployments.

Task 5: Assess the best option for long-term development of FRMCS and develop EU-harmonised technical conditions

As per Directive 2016/797/EU, railway interoperability means the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance. RMR and ETCS, as constituents of ERTMS, offer an interoperable railway communication and signalling system to all European railway networks. Spectrum harmonisation for railways is part of this process. In order to enable parallel operation of GSM-R and its successor during migration without degradation to GSM-R and to benefit from new railway critical applications during and beyond migration, access to sufficient harmonised spectrum for RMR is essential.

The paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz and the unpaired frequency band 1900-1910 MHz have been identified by CEPT as the most appropriate spectrum bands for RMR, as outlined in CEPT Report 74 [1].

The harmonised technical conditions for GSM-R in 874.4-880.0 MHz / 919.4-925.0 MHz are provided in section 3.1 and the harmonised least restrictive technical conditions for wideband RMR (FRMCS) in 874.4-880.0 MHz / 919.4-925.0 MHz are provided in section 3.2.

National regulation may allow multiple carriers using wideband technologies[2] or higher e.i.r.p. for RMR BS than stated in the technical conditions, as long as the absence of harmful interference on ECS BS can be ensured. CEPT Report 74 (section 4.2.1.2) gives an example of a coexistence criterion as part of a national coordination procedure. The relevant national coordination procedure may differ from country to country, considering that coordination procedures with regard to ECS / GSM-R are already in force based on the guidance as described in ECC Report 229 [11].

The harmonised least restrictive technical conditions for wideband RMR (FRMCS) in 1900-1910 MHz are provided in section 4.1. The BEM for wideband RMR BS assumes that ECS BS have enhanced selectivity compared to the current Harmonised European Standards. This would facilitate coexistence with RMR BS transmitting up to 65 dBm e.i.r.p. ECS BS located near an RMR radio site which do not meet the enhanced selectivity criterion may need to be adapted so that they do not suffer interference. Operators of mobile networks in 1920-1980 MHz should have, sufficiently far in advance, information on the rollout of a new RMR BS in 1900-1910 MHz. Enhanced selectivity should be included (potentially as a specific receiver class) in the relevant ECS BS Harmonised European Standards in order to ensure the future availability of products placed on the market that fulfil this requirement.

RMR receivers (BS and cab-radios) should be robust against emissions adjacent in frequency. The technical conditions for RMR receivers are provided in Annexes 2 and 3 to the present Report.

The technical conditions as proposed in this Report have been developed on the basis of CEPT's technical studies documented in ECC Reports 318 [10], 313 [12] and 314 [13].

[1] Ares(2018)3947109 - 25/07/2018 at https://ec.europa.eu/digital-single-market/en/news/radio-spectrum-cept-mandates-0

[2] LTE or NR, including NB-IoT

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
3GPP	3rd Generation Partnership Project
AAS	Active Antenna System
ACLR	Adjacent Channel Leakage power Ratio
BEM	Block Edge Mask
BW	Bandwidth
BS	Base Station
CCS	Control-Command and Signalling
CEPT	European Conference of Postal and Telecommunications Administrations
CW	Continuous Wave
DL	Downlink
EC	European Commission
ECC	Electronic Communications Committee
ECS	Electronic Communications Services
e.i.r.p.	Equivalent Isotropic Radiated Power
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
ETSI	European Telecommunications Standardisation Institute
EU	European Union
FRMCS	Future Railway Mobile Communication System
GSM	Global System for Mobile communications
GSM-R	GSM for Railway
LRTC	Least Restrictive Technical Conditions
LTE	Long Term Evolution
MFCN	Mobile and Fixed Communication Networks
NAP	Network Access Point
NB-IoT	Narrowband Internet of Things
OOB	Out-of-Band
RFID	Radio Frequency Identification
RMR	Railway Mobile Radio
RefSens	Reference Sensitivity
SRD	Short Range Devices
TSI	Technical Specification for Interoperability
UAS	Unmanned Aircraft System
UIC	International Union of Railways
UL	Uplink

1 INTRODUCTION

This Report has been developed by the European Conference of Postal and Telecommunications Administrations (CEPT) in response to the Mandate from the European Commission to CEPT on spectrum for the future railway mobile communications system (FRMCS), in particular to task 5.

- Task 5 relates to the selection of the best option for long term development of FRMCS and to the development of EU-harmonised technical conditions, possibly for shared spectrum use, for the future railway mobile radio communications system, which are suitable for both the migration period and after the GSM-R switch-off, taking into account the results of tasks 1, 2, 3 and 4.

This Report complements CEPT Report 74 [1] related to tasks 1 to 4 and only considers non-AAS FRMCS. Additional studies should be performed in case AAS are considered for FRMCS deployments.

2 REASONING FOR THE HARMONISED CONDITIONS

2.1 DEFINITIONS

Term	Definition
Cab-radio	In this Report, the mobile radio equipment installed on-board the train capable of supporting both voice and data applications (e.g. ETCS)
ETCS (European Train Control System)	Applicative protocol for railway signalling and train protection to enable railway interoperability at European level
GSM-R (GSM for Railway)	Current radiocommunication network for railways, which provides voice services (including emergency voice calls) and carries ETCS and other data services
Infrastructure Manager	The entity who administrates the rail track network and the associated radio access network (today GSM-R)
Movement authority	Information about where the train is allowed to safely move
Railway interoperability	Ability for trains and staff to operate uninterruptedly across borders and railway networks (requirement defined in the EU Directive 2016/797 [2], supplemented by Commission Delegated Decision (EU) 2017/1474 [3], formerly EC Directive 2008/57)
Railway Mobile Radio	Encompasses GSM-R and its successor(s), including the Future Railway Mobile Communication System (FRMCS)
Railway signalling	Speed limits and movement authorities (provided by trackside signals, balises or wireless communications)
Railway Undertaking	A company which operates trains and thus uses the radio access network (today GSM-R) provided by the Infrastructure Manager
RefSens	The minimum mean power received at the antenna connector at which a specified minimum performance shall be met

2.2 RAILWAY INTEROPERABILITY

The interoperability of the European railway system is ensured today by the regulatory framework provided by the Railway Interoperability Directive [2] and the Control-Command and Signalling Technical Specifications for Interoperability (CCS TSI) [4].

In the Directive 2016/797/EU [2] on the interoperability of the railway system within the Community, the definition of railway interoperability can be found in its Article 2:

> *'interoperability' means the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance;*

It is mandatory that each railway subsystem (train and infrastructure) in the European Union meets these requirements under the scope of the Railway Interoperability Directive [2], it is to ensure technical compatibility between Member States and safe integration between train and track. Radio related requirements on spectrum, coverage and signal strength are amongst these.

RMR and ETCS, as constituents of ERTMS, offer an interoperable railway communication and signalling system to all European railway networks and that spectrum harmonisation for railways is part of this process.

2.3 MIGRATION AND BEYOND

As of today, the application of the Control-Command and Signalling Technical Specification for Interoperability (CCS TSI) [4] does not have retroactive effect. In general, new TSIs are developed ensuring the compatibility with the existing authorised systems, to avoid the requirement of upgrading them, as per the "*Whereas (16)*" of the Interoperability Directive [2]. This discards in general actions such as a mandatory retrofit of cab-radios (unless specific rules are agreed).

Both technologies, GSM-R and FRMCS, will have to operate in parallel during the migration period from GSM-R to the new technology. Migration requires a long-term strategy as non-discriminating access to the rail network is legally required due to interoperability requirements.

The overall migration throughout Europe is expected to take place between 2024 and 2035.

2.4 REUSE OF THE 900 MHZ BAND

Having the possibility to reuse as much as possible the current radio network infrastructure (BS sites) would save costs, time and reduce operational burden. Therefore, the spectrum in the whole 2x5.6 MHz in 874.4-880 MHz / 919.4-925 MHz is one of the two bands identified for the successor to GSM-R, for the migration and beyond.

2.5 NEED FOR A COMPLEMENTARY BAND

In order to fulfil the interoperability requirements, to manage the migration from GSM-R and to benefit from new railway critical applications (such as Automatic Train Operation, remote control of engine, train integrity and sensing), sufficient spectrum for both GSM-R and its successor is essential. The 1900-1910 MHz frequency band is the other frequency band identified for the successor to GSM-R, for the migration and beyond.

2.6 CURRENT SPECTRUM REGULATORY FRAMEWORK FOR RAILWAY APPLICATIONS

Commission Decision 1999/569/EC [5] harmonises two frequency bands for the purpose of railways:

- 876-880 MHz / 921-925 MHz for GSM-R;
- 27.090-27.100 MHz for balise telepowering.

Commission Decision 2006/771/EC [6] as amended [7] on SRD harmonises three frequency bands related to railway balises:

- 0.984-7.484 MHz for Eurobalise to train communication (entry ‘19’);
- 7.3-23 MHz for Euroloop to train communication (entry ‘23’);
- 26.957-27.283 MHz for non-specific SRD (entry ‘28’), whose technical conditions allow balise telepowering in 27.090-27.100 MHz (see CEPT Report 44 [8]).

Hence, when revising the spectrum regulatory framework for RMR at EU level, there is no need to maintain specific provisions for balise telepowering since it is harmonised in the Commission Decision on SRD.

All three bands related to railway balises are also harmonised at CEPT level in ERC Recommendation 70-03, annex 4 [9]. Thus, CEPT decided not to include them in ECC Decision (20)02 on RMR.

3 HARMONISED TECHNICAL CONDITIONS FOR THE 900 MHZ BAND

CEPT recommends that the paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz are identified and harmonised for RMR. The proposed harmonised technical conditions are based on the results of the compatibility studies in ECC Report 318 [10].

3.1 GSM-R

For GSM-R, the following parameters apply:

- GSM-R DL centre frequency f_{DL} = 921 MHz + n×0.2 MHz[3] where $\{n \in \mathbb{Z} \mid -7 \leq n \leq 19\}$
- GSM-R UL centre frequency $f_{UL} = f_{DL}$ – 45 MHz
- GSM-R channel bandwidth is 200 kHz

Table 1: In-block requirements for GSM-R BS in 919.4-921 MHz uncoordinated deployment

GSM-R channel BW	Maximum e.i.r.p.
200 kHz	= 70.5 dBm + (f_{DL} – 921)×40/3 dB
f_{DL} is the centre frequency in MHz Formula applicable to $f_{DL} \leq$ 921 MHz. There is no e.i.r.p. restriction on GSM-R BS transmitting in the 921-925 MHz frequency band.	

3.2 WIDEBAND RADIO FOR RAILWAY

3.2.1 Technical conditions for RMR BS using wideband technologies

The least restrictive technical conditions (LRTC) defined in this section are in the form of a block-edge mask (BEM) applicable to wideband RMR BS. The BEM is developed on the basis that detailed coordination and cooperation agreements would not be required to be in place prior to network deployment.

To avoid blocking of the mobile terminal by a narrowband interferer adjacent in frequency, a 200 kHz frequency separation may be required between RMR and MFCN. This issue can be addressed at national level.

The technical conditions defined in this section are valid for a single RMR carrier using wideband technologies[4]. Only non-AAS BS are considered.

For radio access technologies other than GSM-R, the following parameters apply:

- The lower edge of the lowest Resource Block shall be ≥ 919.6 MHz.

[3] GSM-R channel raster of 200 kHz

[4] including NB-IoT

Table 2: General in-block requirement not mandatory

RMR channel BW	Maximum e.i.r.p.
Any of the channel BW	The following value may be used by an administration in case an upper bound is desired: = Min {65 dBm/channel , Maximum e.i.r.p. specific to the channel BW}

Table 3: Specific in-block requirements for 5.6 MHz and 5 MHz channels mandatory for uncoordinated deployment

RMR channel BW	Maximum e.i.r.p.
5.6 MHz	= 62 dBm/5.6 MHz
5 MHz	= 64.5 dBm/5 MHz + (f_{DL} – 922.1)×40/3 dB
f_{DL} is the centre frequency in MHz. NB-IoT in-band operation mode without power boost is allowed. NB-IoT guard-band operation mode and in-band operation mode with power boost are not allowed.	

Table 4: Specific in-block requirements for 1.4 MHz and 200 kHz channels mandatory for uncoordinated deployment

RMR channel BW	Maximum e.i.r.p.
1.4 MHz	= 56 dBm/1.4 MHz + (f_{DL} – 920.2)×40/3 dB (Note 1)
200 kHz (Note 2)	= 70.5 dBm/200 kHz + (f_{DL} – 921)×40/3 dB (Note 3)
f_{DL} is the centre frequency in MHz. Note 1: Formula applicable to $f_{DL} \leq 921.7$ MHz. No specific e.i.r.p. restriction above. Note 2: Applicable to NB-IoT standalone operation mode, which is made of one Resource Block. Note 3: Formula applicable to $f_{DL} \leq 921.0$ MHz. No specific e.i.r.p. restriction above.	

Table 5: Out-of-band requirements

MHz from block edge (919.4-925 MHz)	e.i.r.p. limit
$0 \leq \Delta f < 0.2$	32.5 dBm/200 kHz
$0.2 \leq \Delta f < 1$	14 dBm/800 kHz
$1 \leq \Delta f < 10$	5 dBm/MHz
On a case-by-case basis, at a national level, higher OOB limits may be applied.	

Table 6: Baseline requirement

Frequency range	e.i.r.p. limit
880-915 MHz	-49 dBm/5 MHz
This requirement prevails over out-of-band requirements.	

3.2.2 Technical conditions for RMR cab-radio using wideband technologies

For radio access technologies other than GSM-R, the following parameters apply:

- Maximum output power: higher than 23 dBm and up to 31 dBm;
- ACLR: 37 dB minimum;
- Uplink power control is mandatory and shall be activated.

3.2.3 Technical conditions for RMR terminals other than cab-radios, using wideband technologies

For radio access technologies other than GSM-R, the following parameters apply:

- Maximum output power: 23 dBm;
- ACLR: 30 dB minimum;
- Uplink power control is mandatory and shall be activated.

4 HARMONISED TECHNICAL CONDITIONS FOR THE COMPLEMENTARY BAND

CEPT recommends that the unpaired frequency band 1900-1910 MHz is identified and harmonised for RMR. The proposed harmonised technical conditions are based on the results of the compatibility studies in ECC Report 318 [10].

4.1 WIDEBAND RADIO FOR RAILWAY

4.1.1 Technical conditions for RMR BS using wideband technologies

The least restrictive technical conditions (LRTC) defined in this section are in the form of a block-edge mask (BEM) applicable to wideband RMR BS. The BEM is developed on the basis that detailed coordination and cooperation agreements would not be required to be in place prior to network deployment. Only non-AAS BS are considered.

The following parameters apply:

Table 7: General in-block requirement mandatory for uncoordinated deployment

RMR channel BW	Maximum e.i.r.p.
10 MHz	= 65 dBm/10 MHz (Note 1)
Note 1: In case an administration wishes to allow higher e.i.r.p., coordination or other mitigation measures are required.	

Table 8: Baseline requirement

Frequency range	e.i.r.p. limit
1920-1980 MHz	-43 dBm/5 MHz

The BEM for wideband RMR BS assumes that ECS BS have enhanced selectivity compared to the current Harmonised European Standards. This facilitates coexistence with RMR BS transmitting up to 65 dBm e.i.r.p. ECS BS located near an RMR radio site which do not meet the enhanced selectivity criterion may need to be adapted so that they do not suffer interference. Operators of mobile networks in 1920-1980 MHz should have, sufficiently far in advance, information on the rollout of a new RMR BS in 1900-1910 MHz. Enhanced selectivity should be included (potentially as a specific receiver class) in the relevant ECS BS Harmonised European Standards in order to ensure the future availability of products placed on the market that fulfil this requirement.

4.1.2 Technical conditions for RMR cab-radio using wideband technologies

The following parameters apply:

- Maximum output power: 31 dBm;
- ACLR: 37 dB minimum;
- Unwanted output power in 1920-1980 MHz:
  - -25 dBm/MHz maximum in 1920-1925 MHz;
  - -30 dBm/MHz maximum in 1925-1980 MHz.
- Uplink power control is mandatory and shall be activated.

4.1.3 Technical conditions for RMR terminals other than cab-radios, using wideband technologies

The following parameter applies:

- Maximum output power: 23 dBm;
- ACLR: 30 dB minimum;
- Uplink power control is mandatory and shall be activated.

5 CONCLUSIONS

The present CEPT Report answers task 5 of the Mandate from the European Commission to CEPT on spectrum for the future railway mobile communications system (FRMCS)[5].

Only non-AAS FRMCS has been considered. Additional studies should be performed in case AAS are considered for FRMCS deployments.

Task 5: Assess the best option for long-term development of FRMCS and develop EU-harmonised technical conditions

As per Directive 2016/797/EU, railway interoperability means the ability of a rail system to allow the safe and uninterrupted movement of trains which accomplish the required levels of performance. RMR and ETCS, as constituents of ERTMS, offer an interoperable railway communication and signalling system to all European railway networks. Spectrum harmonisation for railways is part of this process. In order to enable parallel operation of GSM-R and its successor during migration without degradation to GSM-R and to benefit from new railway critical applications during and beyond migration, access to sufficient harmonised spectrum for RMR is essential.

The paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz and the unpaired frequency band 1900-1910 MHz have been identified by CEPT as the most appropriate spectrum bands for RMR, as outlined in CEPT Report 74 [1].

The harmonised technical conditions for GSM-R in 874.4-880.0 MHz / 919.4-925.0 MHz are provided in section 3.1 and the harmonised least restrictive technical conditions for wideband RMR (FRMCS) in 874.4-880.0 MHz / 919.4-925.0 MHz are provided in section 3.2.

National regulation may allow multiple carriers using wideband technologies[6] or higher e.i.r.p. for RMR BS than stated in the technical conditions, as long as the absence of harmful interference on ECS BS can be ensured. CEPT Report 74 (section 4.2.1.2) gives an example of a coexistence criterion as part of a national coordination procedure. The relevant national coordination procedure may differ from country to country, considering that coordination procedures with regard to ECS / GSM-R are already in force based on the guidance as described in ECC Report 229 [11].

The harmonised least restrictive technical conditions for wideband RMR (FRMCS) in 1900-1910 MHz are provided in section 4.1. The BEM for wideband RMR BS assumes that ECS BS have enhanced selectivity compared to the current Harmonised European Standards. This would facilitate coexistence with RMR BS transmitting up to 65 dBm e.i.r.p. ECS BS located near an RMR radio site which do not meet the enhanced selectivity criterion may need to be adapted so that they do not suffer interference. Operators of mobile networks in 1920-1980 MHz should have, sufficiently far in advance, information on the rollout of a new RMR BS in 1900-1910 MHz. Enhanced selectivity should be included (potentially as a specific receiver class) in the relevant ECS BS Harmonised European Standards in order to ensure the future availability of products placed on the market that fulfil this requirement.

RMR receivers (BS and cab-radios) should be robust against emissions adjacent in frequency. The technical conditions for RMR receivers are provided in Annexes 2 and 3 to the present Report.

The technical conditions as proposed in this Report have been developed on the basis of CEPT's technical studies documented in ECC Report 318 [10], ECC Report 313 [12] and ECC Report 314 [13].

[5] Ares(2018)3947109 - 25/07/2018 at https://ec.europa.eu/digital-single-market/en/news/radio-spectrum-cept-mandates-0

[6] including NB-IoT

ANNEX 1: CEPT MANDATE

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EUROPEAN COMMISSION
Communications Networks Content & Technology Directorate-General

Electronic Communications Networks & Services
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INTERNAL DOCUMENT

RADIO SPECTRUM COMMITTEE

Working Document

Subject: Draft Mandate to CEPT on spectrum for the future railway mobile communications system.

Opinion of the RSC

pursuant to Advisory Procedure under Article 4 of Regulation 182/2011/EU and Article 4.2 of Radio Spectrum Decision 676/2002/EC

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1. PURPOSE

The objective of this Mandate is to consider the required amount of spectrum, identify appropriate spectrum bands, study technical feasibility and develop harmonised technical conditions for a sustainable and efficient use of such bands for the operation of the future railway mobile communications system (FRMCS), which is the successor of GSM-R.

This mandate specifically invites CEPT to study the following frequency bands for existing and future mission-critical[1] railway mobile communications

- 874.4-880 MHz and 919.4-925 MHz
- 1 900-1 920 MHz

Further spectrum bands, for example the band 2 290-2 400 MHz on a tuning range basis, and use of commercial mobile networks may also be studied. In this regard, the progressive phase-out of the existing GSM-R technology and the need for coexistence and simultaneous operation of the existing and the forthcoming system for up to several years should be considered, also in terms of spectrum needs.

2. EU POLICY CONTEXT

Railways are essential for the EU economy. The European railway network covers over 220 000 km of lines and carries 9 billion passengers and 1 700 million tonnes of freight per year[2].The frequency bands to be studied and commercial networks should be considered as a possibility to support railway digitalisation and innovation.

The radiocommunication system used for railway operation is currently GSM-R. Today over 100 000 km of railway lines are operated by GSM-R[3] and this amount is still growing. It is defined through the basic parameters included in section 4 of the CCS TSI[4]. The air interface is specified to use the R-GSM[5] band (see table 3-A in 3.5.1 of the EIRENE SRS). The so-called "UIC band" reserved for GSM-R operation is 876-880/921-925 MHz. These bands are harmonised EU-wide by Commission Decision 1999/569/EC of 28 July 1999[6], which in its Article 2 provides that *"The*

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[1] Mission *Critical: applications that are essential for train movements and safety or a legal obligation, such as emergency communications, shunting, presence, trackside maintenance and Automatic Train Control (as described in UIC FRMCS User Requirement Specification v3.0.0. Art 4.1.3).* https://uic.org/IMG/pdf/fu-7100-3.0.0.pdf

[2] Source: *"The economic footprint of railway transport in Europe"*, CER 2014.

[3] Source: UIC.

[4] Control Command and Signalling Technical Specifications for Interoperability. http://www.era.europa.eu/Core-Activities/ERTMS/Pages/Current-Legal-Reference.aspx

[5] GSM-R refers to the radio elements of ERTMS (network and equipment) while R GSM is a designation for the frequency band 876-915 & 921-960 MHz. This includes the public mobile GSM network.

[6] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01999D0569-19990729&qid=1519396120758&from=EN

frequency bands used for GSM-R radio links shall be 876-880 MHz for the train-to-ground link and 921/925 MHz for the ground-to-train link". These bands are used on a shared basis with others usages at national level (e.g. Defence) to ensure an efficient usage of the spectrum while ensuring an effective coexistence of these different usages.

As telecommunication standards are evolving and new railway applications are needed, GSM technology will become obsolete at some stage. The manufacturing industry is unlikely to support the GSM technology after 2030 and given the long time needed for selecting a technology and making it ready for operation, work has started at various levels (UIC, ERA, CEPT, ETSI…) on the definition of the most suitable radio technology and frequency bands for railway communications of the next generation. CEPT is preparing two ECC reports, respectively on spectrum requirements and on candidate bands for the implementation of the successor to GSM-R.

In its Opinion on ITS published in February 2017[7], the RSPG highlighted that it will be important to ensure interoperability for FRMCS across Member States. A common approach to make spectrum available for the future railway mobile communications system across the EU would ease implementation.

Recent discussions in the Radio Spectrum Committee and CEPT have shown that the 874.4-880 MHz and 919.4-925 MHz bands as well as the 1 900-1 920 MHz band are the currently most prominent options under investigation for mission-critical operation purposes for the future rail mobile communication system. However, other frequency bands, for example 2 290-2 400 MHz on a tuning range basis are also still under investigation within CEPT as an alternative to the 1 900-1 920 MHz frequency band.

Concerning the 900 MHz range, CEPT is still investigating the total spectrum requirement needed after the GSM R switch off to handle all existing and new railway critical applications. Depending on the result of this CEPT investigation, the remaining spectrum could be considered for other applications such as SRD including RFID.

Within CEPT, the 1 900-1 920 MHz is also identified as a possible band to respond to future needs for professional drones/UAS. ETSI has proposed DECT evolution in 1 900-1 920 MHz[8]. Above 1 920 MHz, the spectrum band is widely and heavily used by WBB ECS.

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[7] https://circabc.europa.eu/sd/a/b30590d7-5190-480b-b1d1-def24719e061/RSPG17-008-Final_opinion_ITS.pdf

[8] TR103 149 (2013).

3. JUSTIFICATION

Pursuant to Article 4(2) of the Radio Spectrum Decision[9], the Commission may issue mandates to the CEPT for the development of technical implementing measures with a view to ensuring harmonised conditions for the availability and efficient use of radio spectrum necessary for the functioning of the internal market. Such mandates shall set the tasks to be performed and their timetable.

The Radio Spectrum Policy Programme[10] (RSPP) requires that Member States, in cooperation with the Commission, ensure spectrum availability *"improving transport systems (...) and for intelligent transport safety and transport management systems"*[11].

Noting the work of CEPT, ERA, UIC, the evolving work of ETSI and the wider cooperation among stakeholders, the EU regulatory framework on the harmonised use of radio spectrum for railways should be updated in order to take into account the spectrum needs for the future railway mobile communications system taking into account the required migration phase.

4. TASK ORDER AND SCHEDULE

In order to support a common approach to spectrum for the future railway mobile communications system across the EU, CEPT is mandated to carry out the following technical tasks:

Task 1 Assess the spectrum needs for mission critical operation of the future railway mobile radio communications system (successor system of GSM-R) in terms of required amount of spectrum and frequency ranges. Study solutions for the typical/average need and increased need at limited geographical areas (hotspots) separately.

Task 2 Based on results of task 1, assess the technical feasibility for operating the successor system in the 874.4-880 MHz / 919.4-925 MHz frequency band while ensuring simultaneous operation of GSM-R and the successor system in these bands during a migration period. In this regard, take into account the spectrum needs, requirements and reliability needsof the railway system and ensure coexistence with services in adjacent bands (ECS below 915 MHz and above 925 MHz, SRD and Defence)[12].

Task 3 Based on results of task 1, assess the technical feasibility for operating the successor system (FRMCS) in part of the 1 900-1 920 MHz frequency band

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[9] 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, OJ L108 of 24.4.2002.

[10] Decision 243/2012/EU of 14 March 2012, OJ L81 of 21.3.2012.

[11] Article 8 (1) of the RSPP.

[12] Cfr. RSCOM17-50 and RSCOM17-60

in addition to the band mentioned in task 2 while taking into account the specific requirements of the railway system and ensuring coexistence with adjacent use. In this regard, study the impact of shared use between the railway system and other systems under study within this band, with the objective of safeguarding the railway system. In addition, and if necessary, assess the technical feasibility for operating the successor system (FRMCS) in another frequency band.

Task 4 Study and assess the technical feasibility and scenarios of using commercial mobile networks, taking into account wireless coverage and reliability needs of the railway system.

Task 5 Assess the best option for long term development of FRMCS and develop EU-harmonised technical conditions, possibly for shared spectrum use, for the future railway mobile radio communications system, which are suitable for both the migration period and after the GSM-R switch-off, taking into account the results of tasks 1, 2, 3 and 4.

In performing the tasks above, CEPT should take due consideration of the anticipated simultaneous operation between GSM-R and the future railway mobile communications system for several years, which may necessitate a solution for temporary supplementary spectrum allocation for the migration period. During the migration period, pan-European railway interoperability rules are assumed to continue relying on GSM-R carriers within 876-880 / 921-925 MHz frequency bands.

CEPT should work in cooperation with ETSI, as appropriate. CEPT should also ensure close cooperation with all concerned stakeholders when assessing scenarios and developing technical conditions for the shared use of spectrum. It is assumed that receiver characteristics of the future railway mobile communications system (for user terminals and possibly base stations) should fulfil the specific railway availability requirements and ensure appropriate co-existence with services in adjacent bands.

In the work carried out under the Mandate, the overall policy objectives of the Radio Spectrum Policy Programme (RSPP) such as effective and efficient spectrum use and the support for specific Union policies shall be given utmost consideration. When carrying out studies based on this Mandate, the CEPT shall, whenever relevant, take utmost account of the applicable EU law and support the principles of service and technological neutrality, non-discrimination and proportionality insofar as technically possible.

CEPT should provide deliverables under this Mandate according to the following schedule:

Delivery date	**Deliverable**	**Subject**
March 2020	Final draft CEPT Report A to the Commission	Draft results under tasks 1, 2, 3 and 4
July 2020	Final CEPT Report A to the Commission taking into account the outcome of the public consultation	Final results under tasks 1, 2, 3 and 4
July 2020	Final draft CEPT Report B to the Commission	Draft results under task 5

November 2020	Final CEPT Report B to the Commission taking into account the outcome of the public consultation	Final results under task 5

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

The Commission, with the assistance of the Radio Spectrum Committee and pursuant to the Radio Spectrum Decision, may consider applying the results of this mandate in the Union, pursuant to Article 4 of the Radio Spectrum Decision and having taken into account any relevant guidance of the RSPG.

ANNEX 2: TECHNICAL CONDITIONS FOR RMR RECEIVERS AT 900 MHZ

According to ECC Report 313 [12], the introduction of RMR at 900 MHz is feasible under the condition that the RMR receivers fulfil some requirements more stringent than those currently specified by 3GPP for band #8. It is up to ETSI to define the relevant specification against which the conformity test will be performed.

A2.1 RMR BS RECEIVER

The following radio environment has been considered:

- NAP above rooftop, as part of 500 mW SRD in data networks;
- Loss between NAP antenna and wideband RMR BS connector derived from statistics in ECC Report 318 [10] relying on existing GSM-R and ECS deployment data.

Table 9: Requirements on wideband RMR BS receiver characteristics

Parameter	Value
Level of the wanted signal	RefSens + 3 dB
Maximum interfering signal in 870-874.4 MHz (Note 1)	-34 dBm
The antenna connector of the radio module is the reference point. These requirements cover both blocking and third-order intermodulation. Note 1: It is up to ETSI to define a relevant interfering signal against which the conformity test will be performed. In this Report, the considered bandwidth of the interfering signal is 200 kHz wide.	

A2.2 RMR CAB-RADIO RECEIVER

The following radio environment has been considered:

- Below 919.4 MHz, the most challenging outdoor RFID scenario has been considered;
  - RFID interrogator in the opposite direction to rail tracks;
  - RFID antenna height of 2.4 m;
  - Distance from rail tracks of 20 m.
- Above 925 MHz, UIC's report O-8736 [14] has been reused.

A2.2.1 GSM-R cab-radio receiver

Table 10: Additional requirements on GSM-R cab-radio receiver characteristics

Parameter	Value
Level of the wanted signal	RefSens + 3 dB
Maximum interfering signal in 916.1-918.9 MHz (Note 1)	-26 dBm
The antenna connector of the radio module is the reference point. These requirements cover both blocking and third-order intermodulation. Note 1: It is up to ETSI to define a relevant interfering signal against which the conformity test will be performed. In this Report, the considered bandwidth of the RFID interfering signal is 400 kHz wide.	

Improved GSM-R cab-radios as per ETSI TS 102 933-1 [15] are currently being deployed and are specified for the improved reception of GSM-R in the vicinity of intensive ECS emissions above 925 MHz, but the current GSM-R cab-radio receiver specification is less resilient against adjacent emissions from higher-power SRD

below 919.4 MHz in some close proximity cases. Administrations may further consider the protection of GSM-R cab-radios[7] if the requirements in 916.1-918.9 MHz on the GSM-R cab-radio receiver in the table above are not met.

A2.2.2 Wideband RMR cab-radio receiver

Table 11: Requirements only for wideband RMR cab-radio receiver characteristics[8]

Parameter	Value
Level of the wanted signal	RefSens + 3 dB
Maximum interfering signal in 880-918.9 MHz (Note 1)	-26 dBm
Maximum CW interfering signal in 925.6-927 MHz	-13 dBm
Maximum CW interfering signal in 927-960 MHz	-10 dBm
Maximum 5 MHz LTE interfering signal (lowest carrier at 927.6 MHz)	-13 dBm
The antenna connector of the radio module is the reference point. These requirements cover both blocking and third-order intermodulation. Note 1: It is up to ETSI to define a relevant interfering signal against which the conformity test will be performed. In this Report, the considered bandwidth of the RFID interfering signal is 400 kHz wide.	

Additional external filtering to improve the cab-radio receiver performance may be installed at a national level as part of the railway regulation.

[7] National coordination is allowed as per Note 7 relative to the table on the harmonised technical conditions for SRD in Decision (EU) 2018/1538.

[8] Requirements for RMR terminal receiver other than cab-radio are not covered in this table

ANNEX 3: TECHNICAL CONDITIONS FOR WIDEBAND RMR RECEIVERS AT 1900 MHZ

According to ECC Report 314 [13], the introduction of RMR at 1900 MHz is feasible under the condition that the wideband RMR receivers fulfil some requirements more stringent than those currently specified by 3GPP for band #39. It is up to ETSI to define the relevant specification against which the conformity test will be performed.

A3.1 WIDEBAND RMR BS RECEIVER

The following radio environment has been considered:

- ECS BS above rooftop;
- 3GPP's radio frequency system scenarios reused, with an LTE interfering signal instead of a CW one.

Table 12: Requirements on wideband RMR BS receiver characteristics

Parameter	Value
Level of the wanted signal	RefSens + 3 dB
Maximum 5 MHz LTE interfering signal in 1805-1880 MHz	-20 dBm
The antenna connector of the BS receiver is the reference point. These requirements cover both blocking and third-order intermodulation.	

A3.2 WIDEBAND RMR CAB-RADIO RECEIVER

The following radio environment has been considered:

- Below 1880 MHz, UIC's report O-8736 [14] has been reused;
- Above 1920 MHz, an aerial UE at 30 m separation distance has been considered.

Table 13: Requirements only for wideband RMR cab-radio receiver characteristics[9]

Parameter	Value
Level of the wanted signal	RefSens + 3 dB
Maximum 5 MHz LTE interfering signal in 1805-1880 MHz	-13 dBm
Maximum 5 MHz LTE interfering signal in 1920-1980 MHz	-39 dBm
The antenna connector of the radio module is the reference point. These requirements cover both blocking and third-order intermodulation.	

Depending on the possible introduction of governmental UAS in 1880-1920 MHz in Europe, FRMCS and governmental UAS may need to coexist and it would be up to the ETSI to define, based on ECC Report 314, Table 15 [13], a maximum 5 MHz LTE interfering signal level when a governmental UAS is in use not in the immediate vicinity of the rail tracks but close enough to cause harmful interference.

[9] Requirements for RMR terminal receiver other than cab-radio are not covered in this table

ANNEX 4: LIST OF REFERENCES

[1] CEPT Report 74: “Report from CEPT to the European Commission in response to the Mandate on spectrum for the future railway mobile communications system; Spectrum needs and feasibility”, approved July 2020

[2] Directive (EU) 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union

[3] Commission Delegated Decision (EU) 2017/1474 of 8 June 2017 supplementing Directive (EU) 2016/797 of the European Parliament and of the Council with regard to specific objectives for the drafting, adoption and review of technical specifications for interoperability

[4] Commission Regulation (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the ‘control-command and signalling’ subsystems of the rail system in the European Union

[5] Commission Decision of 28 July 1999 on the basic parameters for the command-and-control and signalling subsystem relating to the trans-European high-speed rail system (1999/569/EC)

[6] Commission Decision of 9 November 2006 on harmonisation of the radio spectrum for use by short-range devices(2006/771/EC)

[7] Commission Implementing Decision (EU) 2019/1345 of 2 August 2019 amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices

[8] CEPT Report 44: “Response to the EC Permanent Mandate on the “Annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by short range devices”, approved March 2013

[9] ERC Recommendation 70-03: “Relating to the use of Short Range Devices”, approved October 2009 and all subsequent versions

[10] ECC Report 318: “Compatibility between RMR and MFCN in the 900 MHz range, the 1900-1910 MHz band and the 2290-2300 MHz band”, approved July 2020

[11] ECC Report 229: “Guidance for improving coexistence between GSM-R and MFCN in the 900 MHz band”, approved May 2015

[12] ECC Report 313: “Coexistence between RMR in the 900 MHz range and other applications in adjacent bands”, approved May 2020

[13] ECC Report 314: “Coexistence between Future Railway Mobile Communication System (FRMCS) in the frequency range 1900-1920 MHz and other applications in adjacent bands”, approved May 2020

[14] UIC O-8736: “Assessment report on GSM-R current and future radio environment”

[15] ETSI TS 102 933-1: “GSM-R improved receiver parameters; Part 1: Requirements for radio reception”