CEPT ECC
Electronic Communications Committee

CEPT Report 90

Report from CEPT to the European Commission in response to the Mandate

"Harmonised technical conditions for introducing the latest technology evolution in the future railway mobile communications system (FRMCS) using the 900 MHz frequency band"

approved on 27 June 2025

0 EXECUTIVE SUMMARY

In order to enable a smooth migration from GSM-R to FRMCS in the 900 MHz frequency band, technical solutions are required and a new option leveraging a 3 MHz channelization can be introduced. The June 2024 revision of ECC Decision (20)02, annex 2 [1] outlines technical and operational conditions, introducing 5G NR 3 MHz channels and narrowband technologies in the 900 MHz frequency band for RMR.

The technical conditions proposed in this CEPT Report, facilitate the transition from GSM-R to FRMCS, in the 900 MHz (n100[1]) frequency band. The GSM-R system currently occupies up to 2x4 MHz in the 900 MHz frequency band[2], leaving only limited spectrum available for FRMCS.

3GPP is developing standards for 5G NR channels with bandwidths smaller than 5 MHz, including in the n100 band. As part of the June 2024 update to ECC Decision (20)02, annex 2, changes were made to define and allow the use of 3 MHz channel bandwidths along with the flexible use of 5G NR resource blocks.

The updated ECC Decision (20)02 also removed the 1.4 MHz LTE-only channelization, which is no longer considered for FRMCS. Further, it allowed more flexible rules for narrowband ≤ 200 kHz technologies in the 900 MHz frequency band.

Based on the conclusion of this CEPT Report, it is proposed to amend the Commission Implementing Decision (EU)2021/1730 [2], as set out in ECC Decision (20)02, annex 2 of June 2024.

[1] 874.4-880 MHz / 919.4-925 MHz

[2] An additional 2x3 MHz (873-876 MHz and 918-921 MHz) may be used on a national basis as extension bands for GSM-R as considered in ECC Decision (19)02 [3].

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
3GPP	3rd Generation Partnership Project
5G NR	5G New Radio
CEPT	European Conference of Postal and Telecommunications Administrations
AAS	Active Antenna Systems
ACLR	Adjacent Channel Leakage power Ratio
BEM	Block Edge Mask
BS	Base Station
BW	Bandwidth
CW	Continuous Wave
ECC	Electronic Communications Committee
e.i.r.p.	equivalent isotropic radiated power
ETSI	European Telecommunications Standards Institute
FRMCS	Future Rail Mobile Communication System
GSM	Global System for Mobile communications
GSM-R	GSM for Railway
LRTC	Least Restrictive Technical Conditions
LTE	Long Term Evolution
NB-IoT	Narrowband Internet of Things
non-AAS	non-Active Antenna Systems
OOB	Out-of-Band
RMR	Railway Mobile Radio
UIC	International Union of Railways

1 INTRODUCTION

Following recent developments in 3GPP, it has been demonstrated that in the 900 MHz frequency band further use cases can be introduced based on channel bandwidths smaller than 5 MHz. In addition, the use can be extended to other narrowband (NB) applications and technologies (currently limited to NB-IoT). This will facilitate the concurrent usage of FRMCS and the Global System for Mobile Communications – Rail (GSM-R) legacy systems in the current infrastructure in this frequency band.

Based on previous investigations, CEPT developed in June 2024 a revision of ECC Decision (20)02, annex 2 [1], harmonised technical and operational conditions, to introduce 3 MHz channel for the use of 5G NR and to enable narrowband use cases other than NB IoT in the 900 MHz frequency bands for RMR. In this Report only non-AAS BS are considered.

2 BACKGROUND

This CEPT Report, to the European Commission, is in response to the EC Mandate "on developing harmonised technical conditions for introducing the latest technology evolution in the future railway mobile communications system (FRMCS) using the 900 MHz frequency band".

The initial November 2020 version of ECC Decision (20)02 [1] harmonised the use of specific frequency bands for RMR across Europe. Specifically, it designated the paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz, as well as the unpaired frequency band 1900-1910 MHz, for RMR. This ECC Decision supports RMR operations and ensures interoperability across borders, for mission critical rail communication.

ECC Decision (20)02 was updated in June 2022 and refers to comparable technical specifications to those set out in Commission Implementing Decision (EU) 2021/1730 of 28 September 2021.

ECC Decision (20)02 was further amended in June 2024. These changes are the subject of this CEPT Report.

For the migration from GSM-R to FRMCS, both the RMR 900 MHz band (3GPP band n100: 874.4-880.0 MHz paired with 919.4-925.0 MHz) and the 1900 MHz band (3GPP band n101: 1900-1910 MHz) will be used. European GSM-R networks are using today the full 2x4 MHz of the GSM-R band. That leaves only 2x1.6 MHz of spectrum in the RMR 900 MHz band that can be used for FRMCS without GSM-R coexistence. In order to enable a smooth migration from GSM-R to FRMCS in the 900 MHz frequency band, new technical possibilities are proposed. The approaches are as follows:

- The use of a 900 MHz 5G NR overlay to GSM-R;
- The use of a 5G NR channel bandwidth smaller than 5 MHz.

Regarding the second approach described above, 3GPP is developing standards offering 5G NR channels with bandwidths smaller than 5 MHz, since ECC Decision (20)02 was initially published. In the context of RMR, this new 5G NR channelization is also planned for the n100 band. Consequently, UIC proposed to CEPT to consider the update of the regulation accordingly. UIC also proposed the removal of the LTE only 1.4 MHz channelization, as it was no longer considered for FRMCS deployment.

Therefore, in June 2024 the ECC Decision (20)02 Annex 2 was further amended. The changes are made in the following tables:

- ECC/DEC/(20)02, annex 2 table 3 – a new Note 1 is amended to allow the flexible use of resource blocks, and reads "The calculation has been based on 25 resource blocks. The formula equally applies to 20 resource blocks.";
- ECC/DEC/(20)02, annex 2 table 4 – for channel bandwidth of 3 MHz the maximum *e.i.r.p.* was set at 61 dBm/3MHz + (f_{DL} – 921.4)×40/3 dB as the methodology to calculate the power density remained unchanged from the previous 1.4 MHz calculation;
- ECC/DEC/(20)02, annex 2 table 4 – the 1.4 MHz channel bandwidth is removed;
- ECC/DEC/(20)02, annex 2 table 4 – the Note 1 is amended to allow the flexible use of resource blocks, and reads "Formula applicable to $f_{DL} \leq 922.5$ MHz. No specific *e.i.r.p.* restriction above. The calculation has been based on 15 resource blocks. It equally applies to 12 resource blocks.";
- ECC/DEC/(20)02, annex 2 table 4 – the Note 2 is amended to allow all narrowband technologies, and reads "Applicable to narrowband technologies.".

Due to these changes other editorial / formatting changes were also made to the amended ECC Decision (20)02, annex 2.

3 CONCLUSIONS

Based on the new options for bandwidths less than 5 MHz, the flexible use of 5G NR resource blocks and the use of other narrowband (NB) applications and technologies (currently limited to NB IoT), it is proposed to amend the Commission Implementing Decision (EU)2021/1730 [2] as follows, based on the June 2024 version of ECC Decision (20)02, annex 2 [1].

Table 1: 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/5.6MHz
5 MHz	= 64.5 dBm/5MHz + (f_{DL} – 922.1)×40/3 dB (Note 1)
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. Note 1: The calculation has been based on 25 Resource Blocks. The formula equally applies to 20 Resource Blocks.	

Table 2: Specific in-block requirements for 3 MHz channels and channels ≤ 200 kHz mandatory for uncoordinated deployment

RMR channel BW	Maximum *e.i.r.p.*
3 MHz	= 61 dBm/3 MHz + (f_{DL} – 921.4)×40/3 dB (Note 1)
200 kHz (Note 2)	= 70.5 dBm/200kHz + (f_{DL} – 921)×40/3 dB (Note 3)
f_{DL} is the centre frequency in MHz. Note 1: Formula applicable to $f_{DL} \leq$ 922.5 MHz. No specific *e.i.r.p.* restriction above. The calculation has been based on 15 Resource Blocks. It equally applies to 12 Resource Blocks. Note 2: Applicable to narrowband technologies. Note 3: Formula applicable to $f_{DL} \leq$ 921.0 MHz. No specific *e.i.r.p.* restriction above.	

ANNEX 1: CEPT MANDATE

Ref. Ares(2024)5504123 - 30/07/2024

EUROPEAN COMMISSION
Communications Networks Content & Technology Directorate-General

Digital Decade and Connectivity
Radio Spectrum Policy

MANDATE TO CEPT ON DEVELOPING HARMONISED TECHNICAL CONDITIONS FOR INTRODUCING THE LATEST TECHNOLOGY EVOLUTION IN THE FUTURE RAILWAY MOBILE COMMUNICATIONS SYSTEM (FRMCS) USING THE 900 MHZ FREQUENCY BAND

1. PURPOSE

The purpose of this mandate to the CEPT is to develop harmonised technical and operational conditions based on investigations already done in the CEPT to introduce use cases with the latest technology evolution for the 874.4-880 MHz and 919.4-925 MHz frequency bands (the '900 MHz band') in the future railway mobile communications system (FRMCS).

2. BACKGROUND

On 28 September 2021, the Commission adopted the Implementing Decision (EU) 2021/1730 on the harmonised use of the paired frequency bands 874.4-880 MHz and 919.4-925 MHz and of the unpaired frequency band 1900-1910 MHz for Railway Mobile Radio[3], starting the development of the FRMCS supporting railway digitisation and innovation in the EU.

Recent investigations in the CEPT[4] have demonstrated that in the 900 MHz band use cases can be introduced based on channels larger than 1.4 MHz, but smaller than 5 MHz and the use can be extended to other narrowband (NB) applications and technologies (currently limited to NB IoT). This will facilitate the concurrent usage of FRMCS and the Global System for Mobile Communications – Rail (GSM-R) legacy systems in the current infrastructure in this frequency band, with evident cost savings.

The provision of channels smaller than 5 MHz using 5G features will play a critical function in the migration from GSM-R to FRMCS and beyond, allowing new devices to be introduced on the market.

Utilising 5G New Radio (NR) in the 900 MHz band will allow reaching the high reliability of communications from and to a moving train, while complying with the end-to-end latency. Therefore, it is appropriate to further develop the EU regulatory framework to accommodate the latest technology evolution, and to ensure its alignment with the CEPT framework.

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[3] Commission Implementing Decision (EU) 2021/1730 of 28 September 2021 on the harmonised use of the paired frequency bands 874,4-880,0 MHz and 919,4-925,0 MHz and of the unpaired frequency band 1900-1910 MHz for Railway Mobile Radio, OJ L 346, 30.9.2021, p. 1.

[4] Based on the CEPT report 74 and ECC report 318.

3. JUSTIFICATION

Pursuant to Article 4(2) of the Radio Spectrum Decision[5] the Commission shall 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.

Considering the recent work of the CEPT and the evolving work of ETSI and related inputs by stakeholders, the EU regulatory framework on the harmonised use of radio spectrum for railways should be updated in order to take into account the latest technology evolution in support of possible new use cases in the 900 MHz band for the FRMCS during the migration period from GSM-R to FRMCS and beyond.

In the work carried out under this 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. In implementing 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.

4. TASK ORDER AND SCHEDULE

In order to support the aforementioned extensions in using the 900 MHz band for the FRMCS across the EU, the CEPT is mandated to carry out the following technical task:

Task

Develop harmonised technical and operational conditions[6] for introducing channels larger than 1.4 MHz, but smaller than 5 MHz for the use of 5G-NR and enable narrowband use cases other than NB-IoT in the 900 MHz frequency bands for RMR.

In performing the task above, the CEPT should take due consideration of the anticipated simultaneous operation between GSM-R and the FRMCS for several years.

The CEPT should work in cooperation with ETSI, as appropriate.

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

Delivery date	**Deliverable**	**Subject**
March 2025	Draft CEPT Report to the Commission[7]	Description of work undertaken and results.

[5] Decision No 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, 24.4.2002, p. 1.

[6] Based on investigations already done in the CEPT

[7] Subject to public consultation.

June 2025	Final CEPT Report to the Commission	Description of work undertaken and final results.

The CEPT is requested to report on the progress of its work pursuant to this mandate to all meetings of the Radio Spectrum Committee (RSC) taking place during the course of this mandate.

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

ANNEX 2: LEAST RESTRICTIVE TECHNICAL CONDITIONS FOR A SINGLE WIDEBAND RMR CARRIER IN 874.4-880.0 MHZ / 919.4-925.0 MHZ

A2.1 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 technical conditions defined in this section are valid for a single RMR carrier using wideband technologies. 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[8] 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.

Table 3: 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 4: 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/5.6MHz
5 MHz	= 64.5 dBm/5MHz + (f_{DL} – 922.1)×40/3 dB (Note 1)
Note: f_{DL} is the centre frequency in MHz. Note: 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. Note 1: The calculation has been based on 25 Resource Blocks. The formula equally applies to 20 Resource Blocks.	

Table 5: Specific in-block requirements for 3 MHz channels and channels ≤ 200 kHz mandatory for uncoordinated deployment

RMR channel BW	Maximum *e.i.r.p.*
3 MHz	= 61 dBm/3 MHz + (f_{DL} – 921.4)×40/3 dB (Note 1)
200 kHz (Note 2)	= 70.5 dBm/200kHz + (f_{DL} – 921)×40/3 dB (Note 3)
Note: f_{DL} is the centre frequency in MHz. Note 1: Formula applicable to $f_{DL} \leq 922.5$ MHz. No specific e.i.r.p. restriction above. The calculation has been based on 15 Resource Blocks. It equally applies to 12 Resource Blocks. Note 2: Applicable to narrowband technologies. Note 3: Formula applicable to $f_{DL} \leq 921.0$ MHz. No specific e.i.r.p. restriction above.	

[8] AAS: Active Antenna System

Table 6: 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
Note: On a case-by-case basis, at a national level, higher OOB limits may be applied.	

Table 7: Baseline requirement

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

A2.2 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[9]: 37 dB minimum;
- Uplink power control is mandatory and shall be activated.

A2.3 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.

A2.4 TECHNICAL CONDITIONS FOR RMR RECEIVERS USING WIDEBAND TECHNOLOGIES

Table 8: 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
Note: The antenna connector of the radio module is the reference point. The reference sensitivity (RefSens) is the minimum mean power received at the antenna connector at which a specified minimum performance shall be met. 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 Decision, CEPT considered a bandwidth of 200 kHz for the interfering signal.	

[9] ACLR: Adjacent Channel Leakage power Ratio

Table 9: Requirements only for wideband RMR cab-radio receiver characteristics[10]

Parameter	Value
Level of the wanted signal	RefSens + 3 dB
Maximum interfering signal in 880-918.9 MHz (Note 1)	-26 dBm
Maximum CW[11] 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

Note: The antenna connector of the radio module is the reference point. The reference sensitivity (RefSens) is the minimum mean power received at the antenna connector at which a specified minimum performance shall be met.

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 Decision, CEPT considered a bandwidth of 400 kHz for the RFID interfering signal.

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

[11] CW: Continuous Wave

ANNEX 3: LIST OF REFERENCES

[1] ECC Decision (20)02: “Harmonised use of the paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz and of the unpaired frequency band 1900-1910 MHz for Railway Mobile Radio (RMR)”, approved 20 November 2020, updated June 2022 and amended 28 June 2024

[2] (EU)2021/1730: “Commission implementing Decision (EU) 2021/1730 of 28 September 2021 on the harmonised use of the paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz and of the unpaired frequency band 1900-1910 MHz for Railway Mobile Radio”

[3] ECC Decision (19)02: “Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1 - 410 MHz, 410-430 MHz, 440-450 MHz and 450-470 MHz”, approved March 2019