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Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Land Mobile Service; Additional spectrum requirements for PMR/PAMR systems operated by railway companies (GSM-R)

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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Introduction

GSM-R systems support railway operations, especially those in accordance with the Council Directive on the interoperability of the trans- European high speed rail systems 1996/48/EC [i.2] and the Commission Decision 1999/569/EC [i.3] and its corrigendum concerning the frequencies for the trans-European high-speed rail system. Railway organizations are making increasingly extensive use of radio communications to facilitate the managing and operating of railway traffic and to increase its safety.

ECC Decision (02)05 [i.1] addresses the use of the bands 876 MHz to 880 MHz and 921 MHz to 925 MHz which are designated for railway operational applications on a European wide basis. This ECC Decision covers exclusively the designation and especially the availability of frequency bands for duplex operation, single frequency simplex operation and frequency planning for railways. Railway operators use up to 19 GSM-R channels within these frequencies.

Applications such as ETCS (European Train Control System) require additional spectrum resources as required by Council Directive 96/48/EC [i.2] (high speed lines) and Directive 2001/16/EC [i.4] (conventional lines) since the ETCS technology permanently demands at least one, in ETCS-handover situations even two timeslots on the air interface for each train on the line. Especially at hubs, this leads to an extreme increase of required frequency resources.

However, it is impossible to cover the overall demand in some cases today and increasingly in the future at railway line nodes with the existing maximum of 19 duplex channels and the additional 5 DMO channels (Direct Mode Operation) within the frequency band from 876 MHz to 880 MHz / 921 MHz to 925 MHz.

Therefore, an extension of the GSM-R spectrum is proposed by the present document. This proposed additional spectrum usage is called GSM-RE in the present document.

It should be noted that the subject of additional spectrum usage by GSM-R was also discussed in the Radio Spectrum Committee (see [i.25] and [i.26]) where it was agreed that if any additional requirements were to be brought to the attention of the RSCom, it would have to be backed by studies showing not only the demand, but also demonstrating the efficient and effective use of existing GSM-R spectrum by state-of-the-art technologies. Comments from several Member States such as Austria, France, Germany and Norway in [i.26] indicate for the medium and long-term developments of GSM-R demand for additional spectrum. The present document is intended to initiate the process for the identification of additional spectrum and encompasses information in support of it.

RSCom has agreed at its 24th meeting (8-9 July 2008) that future spectrum requirements of European railway systems should be kept under observation.

Status of pre-approval draft

The present document has been created by ETSI TC RT (Technical Committee Railway Telecommunications). It was discussed at ERM#35 in June 2008 and has undergone ETSI internal consultation in June - August 2008. It was submitted subsequently to WGFM (in copy to ECC and WGSE) and also amended to resolve remaining comments received during the ETSI internal consultation and updated.

Final approval for publication as ETSI Technical Report is expected at ERM#36 (November 2008).

Target version	**Pre-approval date version (see note)**				
V1.1.1	**a**	**s**	**m**	**Date**	**Description**
V1.1.1		0.0.2		13th April 2008	Draft DB/BMWI for endorsement by TC RT
V1.1.1		0.0.3		15th April 2008	Draft DB/BMWI for endorsement by TC RT
V1.1.1		0.0.4		13th May 2008	Endorsed draft by TC RT including comments from RT chairman
V1.1.1		0.0.5		29th May 2008	Rapporteurs meeting - draft completed for ERM#35 submission
V1.1.1		0.0.6		20th June 2008	Draft at ERM#35 approved for ETSI internal consultation and editHelp processing
V1.1.1		1.1.1_0.0.7		19th August 2008	Draft after incorporation of comments from consultation and editHelp processing
V1.1.1		0.0.8		29 August 2008	Minor editorials.
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V1.1.1		0.0.10		29 August 2008	Clean version of v1.1.1_0.0.9.
V1.1.1		0.0.11		21 October 2008	Outstanding comments resolved and updating
NOTE: See clause A.2 of EG 201 788 [i.5].					

1 Scope

The present document provides information on additional PMR/PAMR spectrum requested for use by railway operators for GSM-R in the duplex frequency band 873 MHz to 876 MHz paired with 918 MHz to 921 MHz. The additional spectrum is needed to satisfy the existing and future spectrum usage requirements of railway operators.

Additional information is given in the following annexes:

- Annex A: Detailed market information.
- Annex B: Detailed technical information.
- Annex C: Expected sharing and compatibility issues.
- Annex D: Response of ETSI TC TETRA on plans for future use of the band by TETRA.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

For online referenced documents, information sufficient to identify and locate the source shall be provided. Preferably, the primary source of the referenced document should be cited, in order to ensure traceability. Furthermore, the reference should, as far as possible, remain valid for the expected life of the document. The reference shall include the method of access to the referenced document and the full network address, with the same punctuation and use of upper case and lower case letters.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ECC Decision (02)05 of 5 July 2002 on the designation and availability of frequency bands for railway purposes in the 876-880 MHz and 921-925 MHz bands.

[i.2] Council Directive 96/48/EC of 23 July 1996 on the interoperability of the trans-European high-speed rail system.

NOTE: There is also Corrigendum to Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system.

[i.3] Commission Decision 1999/569/EC of 28 July 1999 on the basic parameters for the command-and-control and signaling subsystem relating to the trans-European high-speed rail system.

[i.4] Directive 2001/16/EC of the European Parliament and of the Council of 19 March 2001 on the interoperability of the trans-European conventional rail system.

[i.5] ETSI EG 201 788 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guidance for drafting an ETSI System Reference Document".

[i.6] ECC Decision (04)06 of 19 March 2004 on the availability of frequency bands for the introduction of Wide Band Digital Land Mobile PMR/PAMR in the 400 MHz and 800/900 MHz bands.

[i.7] CEPT/ERC Report 25 revised at Nice 2005: "The European table of frequency allocations and utilizations covering the frequency range 9 kHz to 1 000 GHz".

[i.8] ETSI EN 301 502 (V8.1.2):" Harmonized EN for Global System for Mobile communications (GSM);Base Station and Repeater equipment covering essential requirements under article 3.2 of the R&TTE directive (GSM 13.21 version 8.1.2 Release 1999) ".

[i.9] ETSI EN 301 511 (V9.0.2):"Global System for Mobile communications (GSM); Harmonized EN for mobile stations in the GSM 900 and GSM 1800 bands covering essential requirements under article 3.2 of the R&TTE directive (1999/5/EC)".

[i.10] ITU-R Recommendation. P.370-7: "Dependence of field strength on horizon angle theta in ITU-R Recommendation P.370-7".

[i.11] EIRENE SRS, Version 15 (17 May 2006): "European Integrated Railway Radio Enhanced Network, Systems Requirements Specification".

[i.12] EIRENE FRS, Version 7 (17 May 2006): "European Integrated Railway Radio Enhanced Network, Functional Requirements Specification".

[i.13] CEPT ECC Report 34(May 2003): "Compatibility between narrowband digital PMR/PAMR and tactical radio relay in the 900 MHz band, Cavtat".

[i.14] CEPT ECC Report 38 (February 2004): " Technical impact of introducing CDMA-PAMR on the UIC DMO & GSM-R radio systems in the 900 MHz band, Granada".

[i.15] CEPT ECC Report 40 (February 2004): "Adjacent band compatibility between CDMA-PAMR mobile services and short range devices below 870 MHz, Granada".

[i.16] CEPT ECC Report 41 (February 2004): "Adjacent band compatibility between GSM and CDMA-PAMR at 915 MHz", Granada.

[i.17] CEPT ECC Report 58 (October 2004): "Compatibility between tetra release 2 taps and tactical radio relays in the 870-876 and 915-921 MHz bands", Stockholm.

[i.18] CEPT ECC Report 96 (March 2007): "Compatibility between UMTS 900/1800 and systems operating in adjacent bands", Krakow.

[i.19] CEPT ECC Decision (06)12: "ECC Decision of 1 December 2006 on the harmonized conditions for devices using Ultra-Wideband (UWB) technology with Low Duty Cycle (LDC) in the frequency band 3.4-4.8 GHz".

[i.20] ECC Report 5: "Adjacent band compatibility between GSM and TETRA mobile services at 915 MHz".

[i.21] ECC Report 13: "Adjacent band compatibility between TETRA TAPS mobile services at 870 MHz".

[i.22] ECC Report 14: "Adjacent band compatibility of UIC Direct Mode with TETRA Advanced Packet Data Service (TAPS)".

[i.23] ETSI EN 301 419-7: "Digital cellular telecommunications system (Phase 2+) (GSM); Attachment requirements for Global System for Mobile communications (GSM); Railways Band (R-GSM); Mobile Stations; Access (GSM 13.67 version 5.1.1 Release 1996)".

[i.24] ETSI TR 102 649-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRDs and specific SRDs".

[i.25] RSCOM08-19, 26th March 2008: "Spectrum Requirements for Railway Applications".

[i.26] RSCOM08-19 Comments, 27th June 2008: "Spectrum Requirements for Railway Applications".

[i.27] German expert's report from the CET (Consulting, Education and Training GmbH, Professor Dr.-Ing. K. Jobmann).

[i.28] SAGEM Communications (ETSI TC RTd-08004r2 of 22nd January 2008): "GSM Direct Mode Operation - System Requirements".

[i.29] ETSI TS 151 010-1: "Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 1: Conformance specification (3GPP TS 51.010-1 version 4.9.0 Release 4)".

[i.30] ETSI TS 100 910: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP TS 05.05 version 8.9.0 Release 1999)".

[i.31] ETSI GTS 01.04: "European digital cellular telecommunications system (Phase 1); Abbreviations and acronyms (GSM 01.04)".

[i.32] ETSI EN 300 919: "Digital cellular telecommunications system (Phase 2+) (GSM); Types of Mobile Stations (MS) (GSM 02.06 version 7.0.1 Release 1998)".

[i.33] ETSI EN 300 911: "Digital cellular telecommunications system (Phase 2+) (GSM); Radio subsystem link control (GSM 05.08 version 8.4.1 Release 1999)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

ETCS: signaling, control and train protection system designed to replace the 14 incompatible safety systems currently used by European Railways

NOTE: The specification was developed in 1996 in response to EU Council Directive 96/48/EC [i.2] of 23 July 1996 on the interoperability of the trans-European high-speed rail system. ETCS is developed as part of the European Rail Traffic Management System (ERTMS) initiative, and is being tested by six Railway companies since 1999.

European railway networks grew as separate national networks that have little more in common than standard gauge. Notable differences include different voltages, signaling and control systems.

ETCS is divided up into different equipment and functional levels. The definition of the level depends on how the route is equipped and the way in which information is transmitted to the train. Basically, the movement authority ("permission to proceed") and the corresponding route information are transmitted to the train and displayed for the driver in the cab ("cab signaling"). A vehicle fitted with complete ERTMS/ETCS equipment (EuroCab) and functionality can operate on any ETCS route without any technical restrictions.

Technical Specifications for Interoperability (TSI): are being drawn up by the European Association for Railway Interoperability (AEIF)

NOTE: AEIF acts as the joint representative body defined in the Council Directive 96/48/EC [i.2], article 2h, bringing together representatives of the infrastructure managers, railway companies and industry. After the end of the year 2008, ERA (European Railway Agency) will take over this task.

This Directive [i.2] defines interoperability as (art. 2b) "the ability of the Trans-European (…) rail system to allow the safe and uninterrupted movement of (…) trains which accomplish the specified levels of performance. This ability rests on all the regulatory, technical and operational conditions which must be met in order to satisfy essential requirements". These requirements are defined with particular attention to safety, reliability, health and environmental protection for the following sub-systems: infrastructure, energy, control-command and signaling, rolling stock, maintenance and operation.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AMR	Adaptive Multi-Rate codec
BS	Base Station
DB	Deutsche Bahn AG
DMO	Direct Mode Operation
EIRENE	European Integrated Railway radio Enhanced NEtwork
ERTMS	European Railway Traffic Management System
ETCS	European Train Control System
ETSI	European Telecommunications Standards Institute
GSM-R	GSM for Railways
GSM-RE	GSM for Railways (Extended spectrum)
ITU	International Telecommunication Union
MOC	Mobile Originated Call
MS	Mobile Station
MTC	Mobile Terminated Call
OFDM	Orthogonal Frequency Division Multiplex
PAMR	Public Access Mobile Radio
PLMN	Public Land Mobile Network
PMR	Professional (Private) Mobile Radio
RT	Railway Telecommunications
SRDoc	System Reference Document
UHF	Ultra High Frequency
UIC	Union Internationale des Chemins de fer

4 Comments on the System Reference Document

No statements have been received on the present document during the ETSI ERM consultation.

5 Executive summary

5.1 Background information

Additional spectrum for GSM-R applications particularly at tightly linked rail networks with numerous joints, intersections and junctions is needed. The implementation of new applications such as ETCS require new spectrum as well.

An additional demand for 3 MHz duplex within the frequency range from 873 MHz to 876 MHz paired with 918 MHz to 921 MHz as shown in figure 1 is needed.

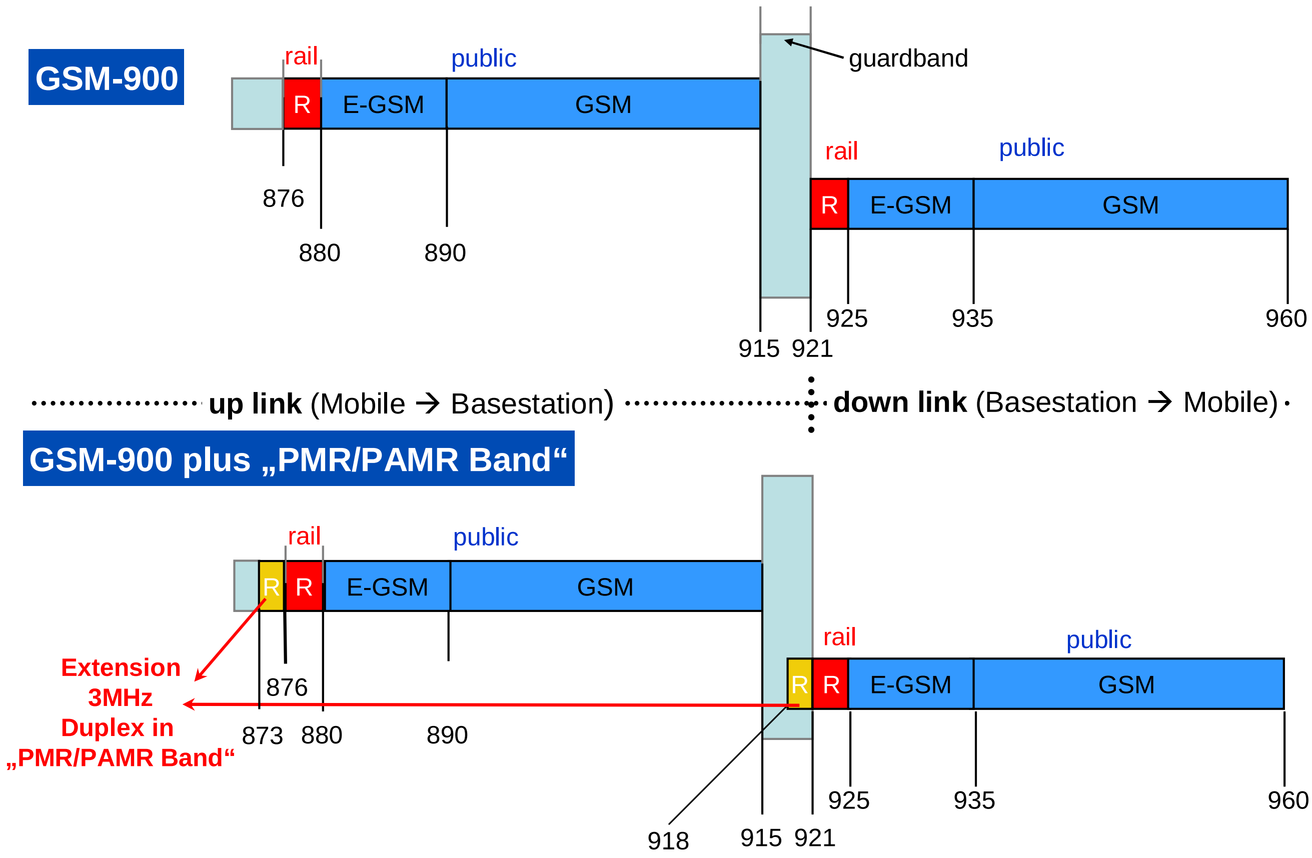


Figure 1: Amendment for additional GSM-R frequencies

It should be noted that GSM 900 originally was being allocated in the 860 MHz to 915 MHz/935 MHz to 960 MHz duplex band. This frequently called "guardband" of 20 MHz in-between uplink and downlink of GSM 900 was later on decreased in two steps by the identification of spectrum for E-GSM and GSM-R, resulting in the remaining GSM 900 "guardband" being decreased to 6 MHz duplex in 870 MHz to 876 MHz paired with 915 MHz to 921 MHz. This band is currently allocated to PMR/PAMR and defense systems.

It has to be noted that there are currently neither TETRA implementations in the "PMR/PAMR" band, nor are any plans. This has currently been confirmed by ETSI TC TETRA (see annex D).

However, ETSI was also informed during the ETSI internal consultation that mobile broadband applications are developed to be provided via Flash-OFDM technology for usage in this frequency band in line with ECC/DEC/(04)06 [i.6].

5.2 Market information

The integration and migration of GSM-R at European railway companies advances very quickly.

At the beginning of 2007, Europe saw the first railway administration completely migrated to GSM-R - Netherlands (3 000 km).

Four more administrations were expected to be migrated by the end of 2007: Norway (3 000 km), Sweden (8 500 km), and another two have completed first step migration: Germany (24 000 km) and Italy (7 500 km).

Norway has finished deploying the GSM-R network. Sweden has finalized their Step 1 (8 500 km) in 2003; Germany is preparing the documents for tendering Step 2, which means 5 000 km more;

Meanwhile railway administrations in Austria, Belgium, Greece, Finland, France, Spain, Switzerland and UK are in the full implementation stage.

Czech Republic intends to finalize the construction phase by the end of 2009, Denmark has awarded the radio planning, Bulgaria has awarded the 50 km ERTMS pilot, with GSM-R component; Hungary is in the tendering process; Croatia, Lithuania, Poland, Romania, Slovenia are preparing for tender.

In Europe, where the total railway network taken into account is 221 025 km, GSM-R coverage is planned for 149 673 km (as shown in table 1). In other words 67,7 %.

On 1st September 2007 the network comprised 60,507 km equipped with GSM-R infrastructure, of which 40 918 were in operation by that date!

That means that 27 % of the network planned to be covered with GSM-R is in operation.

By 2013 most of the administrations will have migrated.

It is expected that 50 % of the GSM-R planned network in Europe to be operational by the end of 2011.

For the mobile users part, of the 384 700 users planned so far (for all European projects), 114 876 are activated, which means almost 30 %. Of these, 17 287 are activated Cab Radios.

Detailed market information is given in annex A.

5.3 Radio Spectrum requirements and justification

Because of the reasons mentioned in annex A the railway administrations need their own radio network. According to the requirements of the national regulating authority, the railway administration must have the functional authority on these GSM-R radio networks.

This radio network is used to fulfill the operational requirements of the railways administration, especially for safety relevant applications. These applications have to be implemented according to the European specification and based on the TSI.

Compared to the public GSM networks, the following additional technical reasons are critical for railway administration:

The system has to run at high speed lines up to 500 km/h.

No disturbance of the radio network caused by the railway specific environment (interference, traction lines, tunnels, cuttings, railway stations).

Dimensioning of the GSM-R network capacity to the peak traffic load.

European specification and commitments according to the TSI.

Hence, it can be concluded that in urban railway centres, the existing 19 channels is not sufficient.

A total additional spectrum requirement of 3 MHz duplex in the duplex frequency range 873 MHz to 876 MHz / 918 MHz to 921 MHz, adjacent to the currently designated spectrum 876 MHz to 880 MHz / 921 MHz to 925 MHz has been determined.

The required spectrum calculation is encompassed in clause B.2.1

5.4 Current Regulations

The current basis for regulation for GSM-R is found in ECC Decision (02)05 [i.1] designating frequency bands for railway purposes in the 876 MHz to 880 MHz and 921 MHz to 925 MHz bands. The frequency band for the extension of GSM-R proposed by the present document is identified for use by Wideband PMR/PAMR in ECC Decision (04)06 [i.6].

The duplex frequency band 870 MHz to 876 MHz / 915 MHz to 921 MHz is also designated for defense systems in ERC Report 25 [i.7] (revised version of 2005): "*The European table of frequency allocations and utilizations covering the frequency range 9 kHz to 1 000 GHz*".

6 Foreseen limits in the Harmonized Standard

The existing transmission parameters for GSM BS and MS as stated in EN 301 502 [i.8] and EN 301 511 [i.9] are valid except for the inclusion of the proposed increased frequency range.

7 Expected ETSI Actions

It is expected that the existing standards [i.8] and [i.9] require modifications to include the proposed additional frequency range for GSM-RE. In addition, EN 301 419-7 [i.23], which includes protocol requirements for GSM-R, needs to be adapted.

Additional ETSI deliverables also need changes:

- TS 151 010-1 [i.29]: "Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 1: Conformance specification (3GPP TS 51.010-1 version 4.9.0 Release 4)".
- TS 100 910 [i.30] (to include the additional frequencies and channel numbering);
- GSM 01.04 [i.31] (abbreviations);
- EN 300 919 [i.32] (types of mobile stations);
- EN 300 911 [i.33] (scan mode of channels).

8 Requested ECC Actions

ECC is requested to designate the duplex bands 873 MHz to 876 MHz / 918 MHz to 921 MHz for railway purposes (GSM-R) in addition to the duplex bands 876 MHz to 880 MHz/921 MHz to 925 MHz, which have already been designated for railway purposes (GSM-R) by ECC Decision (02)05 of 5 July 2002 [i.1].

The usage of the proposed GSM-R Extension bands 873 MHz to 876 MHz/918 MHz to 921 MHz is comparable to PMR/PAMR usage. 200 kHz wideband systems have been studied before and ECC Decision (04)06 was adopted [i.6]. Hence, it has to be assumed that sharing between railway applications (GSM-RE) in the extension bands (873 MHz to 876 MHz / 918 MHz to 921 MHz) and other existing radio applications will be feasible, especially on a regional basis (see also annex C).

In consequence, it seems to be necessary to consider ECC Decision (02)05 [i.1] on the designation and availability of frequency bands for railway purposes in the 876 MHz to 880 MHz/921 MHz to 925 MHz bands and ECC Decision (04)06 [i.6] on the availability of frequency bands for the introduction of wideband digital land mobile PMR/PAMR in the 400 MHz and 800 MHz/900 MHz bands which were developed by WGFM / FM PT 38.

- The designation of the GSM-R extension bands 873 MHz to 876 MHz / 918 MHz to 921 MHz by means of an ECC Decision is requested. An amendment of ECC Decision (02)05 [i.1] or the development of a new ECC Decision seems to be appropriate. This additional demand for GSM-RE is for locations in urban agglomeration where the coverage changes to a planar network for which the amount of required channels increases.

In addition, ECC is requested to facilitate harmonized usage of the bands 873 MHz to 876 MHz / 918 MHz to 921 MHz for railway purposes and initiate discussions with the military frequency management authorities.

In addition, new proposals for radio applications in the proposed frequency bands may need to be studied (see TR 102 649-2 [i.24] for UHF SRD and RFID) on how these could co-exist with GSM-RE.

At the time of completion of the present document, WGFM has already given the task to FM PT 38 to investigate the requested ECC actions.

Annex A: Detailed market information

A.1 Range of applications

Since 2000, Infrastructure Managers of the railways have started in Europe to implement the new standard for digital train radio on the GSM-R system platform (Global System for Mobile Communications - Rail). UIC was thus pioneering the technological transition from the older analogue communications facilities to the new generation of digital systems. The digital system platform GSM-R offers a number of sustainable benefits. Standardization enables operating costs and the time required for system adjustments to be reduced. In addition, the new systems offer user-friendly attributes and improved accessibility for mobile subscribers. By deploying digital transmission technology, UIC members have made train radio system not only more economical, but also the most advanced system in Europe at first and later worldwide.

The impetus for change came from the European legislators. The Council Directive 96/48/EC [i.2] stipulated the introduction of digital technology initially for the trans-European high-speed railway network. In the course of European harmonization and the interoperability of railway transport, GSM-R was later also prescribed in Directive 2001/16/EC [i.4] for the conventional trans-European railway system.

For example, the requisite infrastructure for the GSM-R project was effectively completed in Germany in 2005. About 3 000 base transceiver stations have now been installed, each equipped with its own switching and control interfaces. Train conversion work was also completed on schedule. With the implementation of the GSM-R fixed network components into the DB Netz network management centers and operating control points, all railway sites are now connected to the new mobile radio network. Using new digitally enabled terminals, stationary subscribers, such as signalers located along the lines, can now participate in operative communications via the GSM-R system. A further requirement is connecting the German GSM-R system to the trans-European railway network. Fifty eight border crossings to nine countries need to be prepared. These aspects necessitate close cooperation and consultation with neighboring railways, the relevant supervisory bodies, the Federal Railway Office (EBA) and the regulatory authority for telecommunication and postal services (BNetzA).

The new digital technology permits group calls and all-calls to be made, which allows simultaneous communication with multiple subscribers in, for example, pre-defined radio cells. Calls can be prioritized or suppressed as required. Emergency calls, for example, are assigned absolute priority. The technology is also capable of blocking specific connections so that a driver, for instance, can only be contacted by authorized persons. The introduction of the GSM-R system has also made train radio simpler to use. Besides the person-level addressing previously available, voice calls within the GSM-R system are able to use functional or location-dependent addressing, which is made possible by passing parameters to organizational and rail network data and by configuring the relevant radio cell structure. It is now, for instance, very simple for a signaler to contact the driver of a passing train.

A.2 Train Radio

The main function of train radio is the communication of a train controller station with the train drivers and vice versa. There are the following requirements:

- Bidirectional links for data and voice transmission between train controller stations connected to a fixed railway network and the personnel onboard of trains.
- Call Setup should be possible as mobile terminated call MTC and mobile originated call MOC.
- For MOC and MTC different addressing modes are required for the call setup:
    - MTC (call from a train controller terminal to a train): The call setup should be possible by dialing a (temporary) train running number and a function code. An address translation function from actual train running, engine or coach number and functional identity to real PLMN subscriber number has to be realized. Furthermore it should be possible to address different functions on board the train.

  - MOC (call from a train to a train controller terminal): The actual responsible train controller may change during the journey of a train. The call setup should be possible by pressing a function key or dialing a speed-dial on the mobile station and establishing a connection to the actual responsible train controller dependent on the location of the user.

- Multidirectional links for voice transmission from:

  - one train to multiple mobile and fixed network subscribers.

  - a train controller station to multiple trains.

This requirement means a broadcast function (point to multipoint) to inform e.g. all trains in a defined area or all trains traveling in one direction. These calls could be setup in standard or in emergency case. In an emergency case a fast call setup in about one second is required and the call should be established immediately even if the mobile station is already in use (occupied).

A.2.1 Individual voice call

Individual voice call has to be seen as a supplement of train radio. It covers the wide field of railways operational communication which is characterized by typical functions as available from trunked radio systems.

The technical requirements for individual voice call are defined in EIRENE FRS [i.12].

A.2.2 Shunting

The members of a shunting team have to be able to communicate to each other by pressing a push-to-talk button at the mobile station.

The mobile station itself has to be ruggedized to withstand the existing environmental conditions and modified to allow simplified use.

According to EIRENE FRS [i.12]: "Shunting team members shall be able to communicate with other members of the team as well as with fixed control centers. Typically, a duplex connection is only required for point-to-point calls, whereas group communication is using simplex mode. Talking time of each talker is quite short since only few words will be exchanged".

A closer definition and explanation of shunting radio is available in EIRENE FRS [i.12].

A.2.3 Data messages

Usage of operational short data message or telegram functionality, e.g. for a variety of possible purposes.

A.2.4 ETCS

The European Train Control System (ETCS) is a signaling, control and train protection system designed to replace the 14 incompatible safety systems currently used by European Railways, especially on high-speed lines.

ETCS is divided up into different equipment and functional levels. The definition of the level depends on how the line is equipped and the way in which information is transmitted to the train. Basically, the movement authority ("permission to proceed") and the corresponding route information are transmitted to the train and displayed for the driver in the cab ("cab signaling"). A vehicle fitted with complete ERTMS/ETCS equipment (EuroCab) and functionality can operate on any ETCS lines without any technical restrictions.

The TSI at High Speed Lines and Conventional Lines is the European basis regarding the equipment of these lines (see also EIRENE FRS [i.12]).

See also clause B1.2 for information on ETCS.

A.2.5 Direct Mode Operation (DMO)

The operational requirement for direct mode is to:

- provide short range fall-back communications between train drivers and trackside personnel in the event of failure of mobile telephony services (GSM-R) normally available;
- provide short range communications for railway personnel operating in remote areas where no mobile telephony facilities (GSM-R) are available (see also EIRENE FRS [i.12]).

GSM-R DMO is currently under consideration at 3 GPP GERAN [i.28] and is supposed to be used in the GSM-R frequency band.

A.3 Expected market size and value

At the beginning of 2007 Europe saw the first railway administration completely migrated to GSM-R - Netherlands (3 000 km).

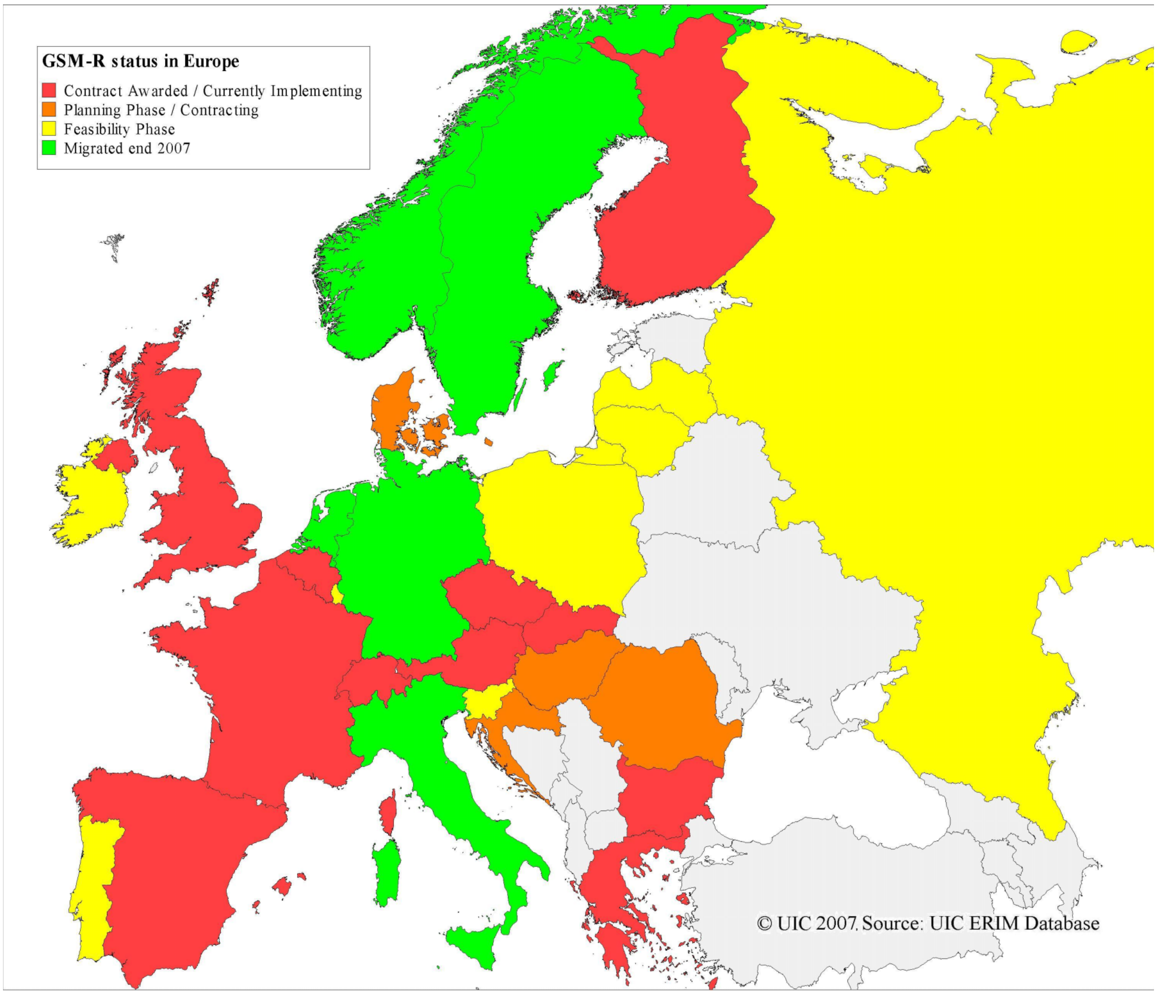


Figure A.1

1st of January 2007, the old analogue radio network, TELERAIL, was switched off.

Four more administrations were expected to be migrated by the end of 2007: Norway (3 000 km), Sweden (8 500 km), and another two will have completed first step migration: Germany (24 000 km) and Italy (7 500 km).

Norway has finished deploying the GSM-R network, at the end of 2007 they migrated to the new system. Sweden has finalized their Step1 (8 500 km) in 2003, having a mixture GSM-R / NMT450. They are now in tender for the remaining low density traffic lines (1 500 km); at the end of 2007 they were expected to have completely migrated to GSM-R. Germany has finalized Step 1 in Q4/2007, that means around 24 000 km. They are preparing the documents for tendering Step 2, which means 5 000 km more. Step 1 for Italy means 7 500 km of Conventional Lines and 110 km for HSL. Conventional Lines were expected to be ready before the end of 2007.

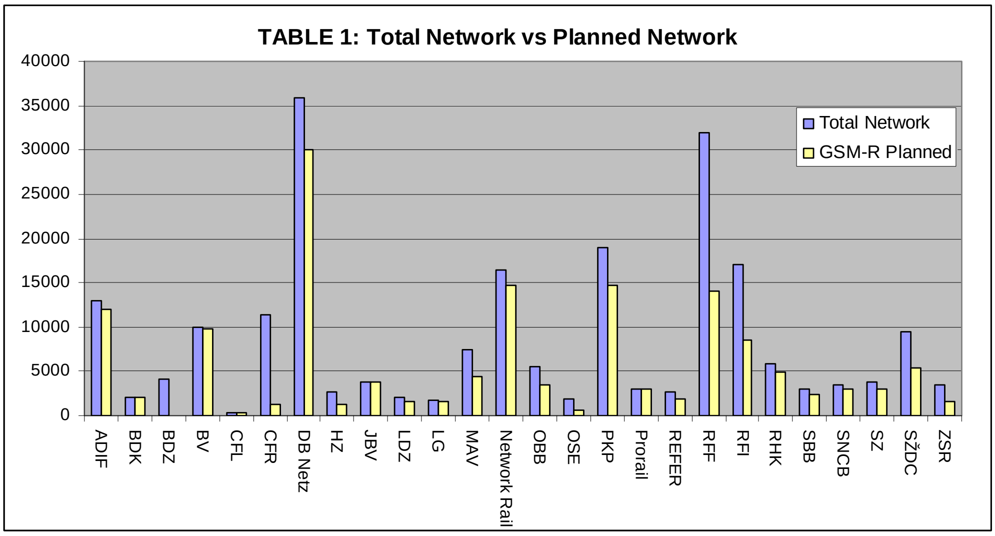
Meanwhile, as shown on the map in figure A.1, certain railway administrations are in the full implementation stage, such as: Austria, Belgium, Greece, Finland, France, Spain, Switzerland and UK.

Czech Republic intends to finalize the construction phase by the end of 2009.

Denmark has awarded the radio planning, it is in progress.

Bulgaria has awarded the 50 km ERTMS pilot, with GSM-R component.

Hungary is in the tendering process; Croatia, Lithuania, Poland, Romania, Slovenia are preparing for tender.



In Europe, where the total railway network taken into account is 221 025 km, GSM-R coverage is planned for 149 673 km (as shown in table 1). In other words 67,7 %.

On 1st September 2007 the network comprised 60 507 km equipped with GSM-R infrastructure, of which 40 918 were in operation by that date!

That means that 27 % of the network planned to be covered with GSM-R is in operation.

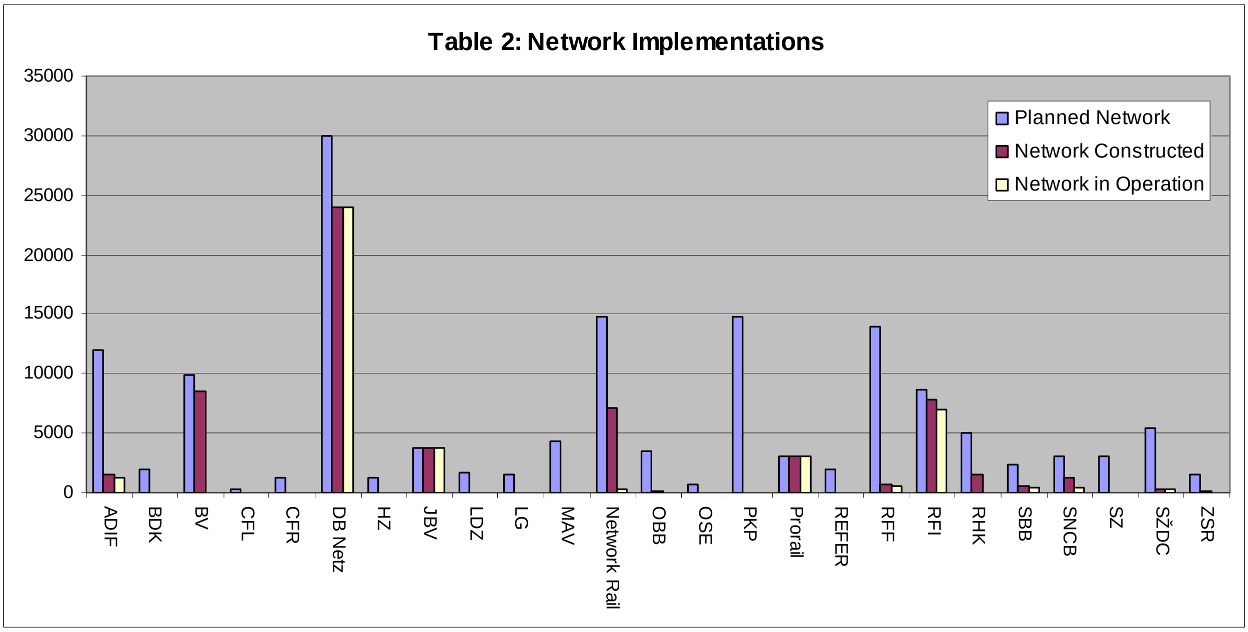


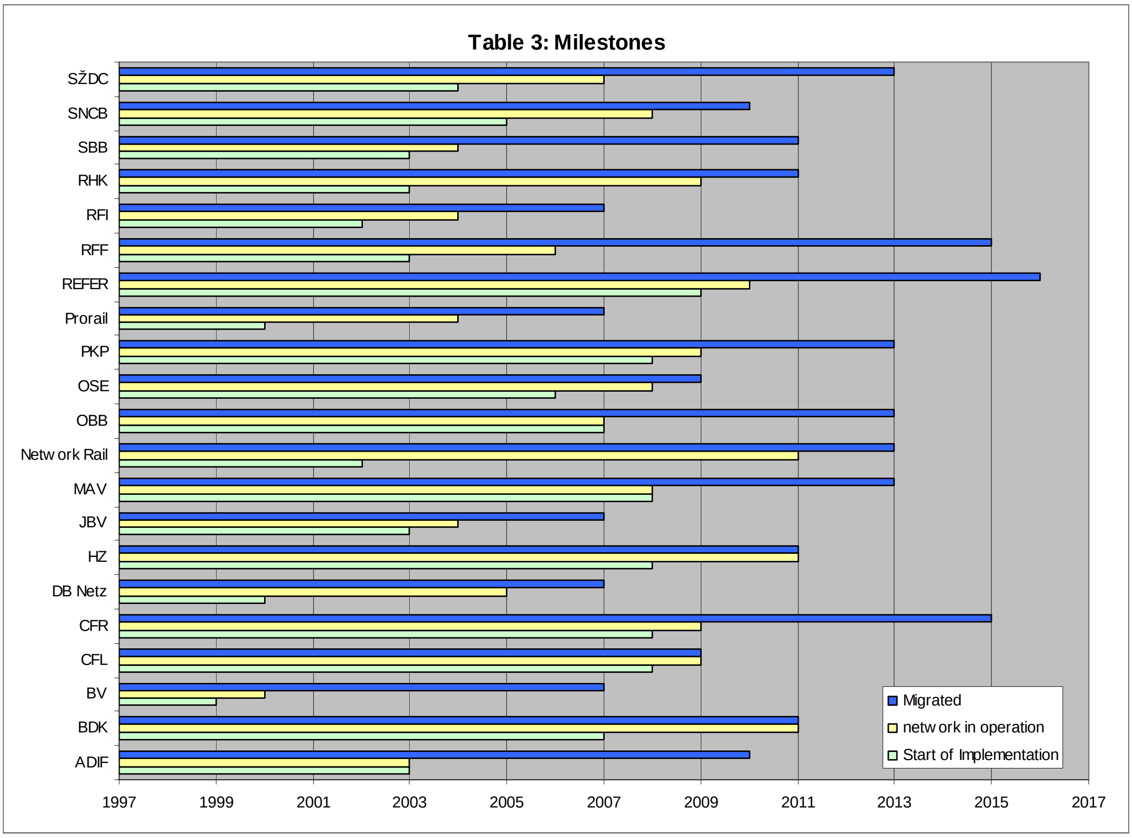
Table 2 shows the GSM-R implementation timetable (based on the national implementation plans).

By 2013 most of the administrations will have migrated. An administration is migrated when the only radio system on the network is GSM-R.

The timetable for some administrations are missing from this plan, such as Bulgaria, Estonia, Latvia, Luxembourg, Slovakia, Serbia, Montenegro, Bosnia-Herzegovina, Albania.

It is expected that 50 % of the GSM-R planned network in Europe to be operational by the end of 2011.

As for coverage of the European Corridors, the current situation is shown below in table 3 and figure A.2, as far as the prognosis for 2010.



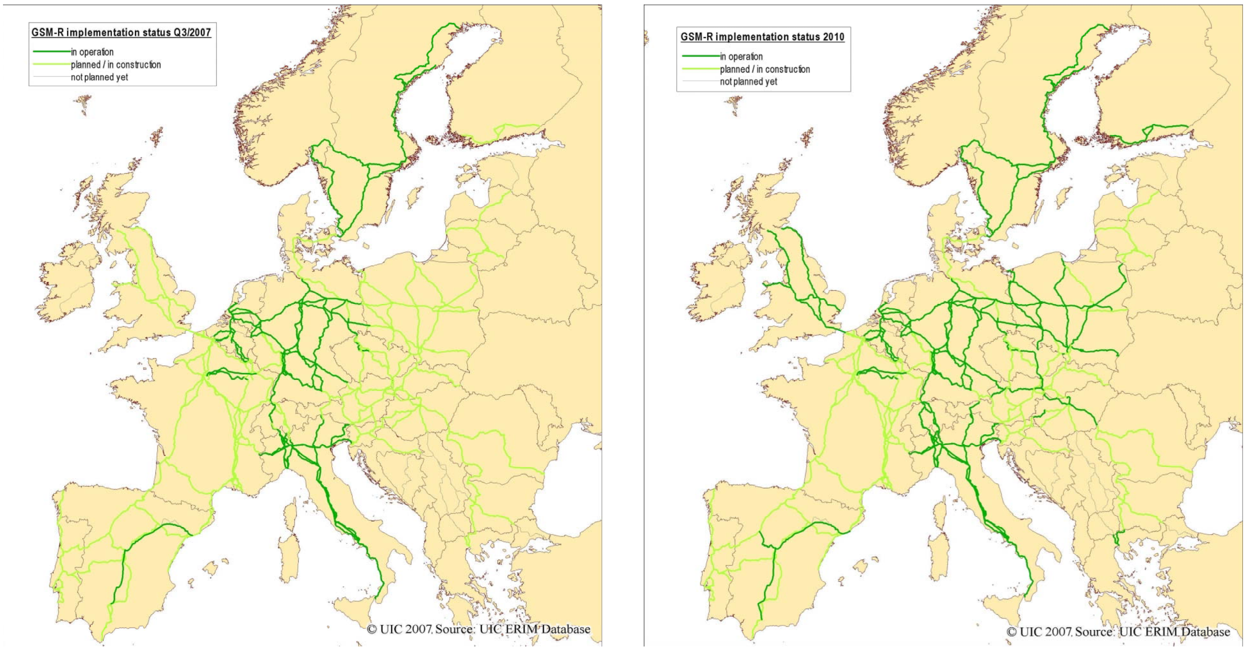


Figure A.2

For the mobile users part, of the 384 700 users planned so far (for all European projects), 114 876 are activated, which means almost 30 %. Of these, 17 287 are activated Cab Radios.

A.3 Deployment

GSM-R is used for safety relevant applications in public railway transport systems. It is used for railway communication along railway lines and in railway related control centers.

Additional demand occurs at railway nodes with peak demand caused by shunting operation and ETCS. Highest frequency demand is expected with integration of ETCS in Europe according to the notified national migration plans, which will soon be harmonized with the international corridor needs.

According to these, the interoperable railway traffic will strongly increase beginning approximately 2012.

Annex B: Detailed technical information

B.1 Detailed technical description

Due to growing access to communication systems in railway components and technology the digital platform GSM-R provides specialized applications in short area and wide area communication and improves logistics in emergency coordination.

With respect on the economic efficiency following requirements have to be provided:

- Compliance to technical specifications for interoperability in TSI [i.11] and [i.12].
- Growing demand on QoS.
- Location depending addressing (*see below*).
- Fast Call Establishment, Short cut usage for users, cell tracking for MS.
- Functional Addressing (*see below*).
- Railway relevant information for passengers from mobile or fixed terminals.
- Communication between drivers of the rolling stock and controllers.
- Intra-Train communication (train staff, more then one train driver [e.g. twin rail cars]).
- Group calls (regional, inter-regional).
- Several time-slots in a single radio-network-cell.
- Railway Emergency calls *"advanced speech call items"* (*see below*).
- Interoperability cross-border.
- High quality network coverage along railway track.
- Planar network at "railway nodes".
- Multi-functional terminals for operators/controllers (train radio and shunting radio functionality).
- speed up to 500 km/h.
- Functionality for ERTMS/ETCS (*see below*).

B.1.2 ETCS

Among other aspects the existing track based signaling systems increase the risk of human errors especially for dense urban and high speed traffic.

One aspect to implement ETCS is, to decrease these risks, which provides partly even safer solutions than today and fulfils at the same time a large variety of requirements of the various European railways. The so defined system - ETCS - brings track side signaling into the driver cabin in various steps. This allows a staged approach and the reduction of complexity for train drivers, who can then concentrate more on their core tasks.

ETCS is specified in three levels. In ETCS Level 1 existing trackside signals are still used. In Level 2 and Level 3 trackside signals are no longer necessary. Signaling and speed restriction information is provided to the train driver via his onboard ETCS display.

In ETCS levels 2 and 3 signaling and train control are implemented by using both trackside equipment such as the EuroBalise and train borne equipment such as the ETCS on board unit and equipment for receiving signals from radio, balises, location devices etc. The trackside ETCS Radio Block Centre interfacing with the existing interlocking provides central monitoring and calculates individual movement authorities used by the ETCS on board unit to generate cab-side signaling. It therefore investigates the according information from the interlocking, the parameters of the track and the respective train asking for authority.

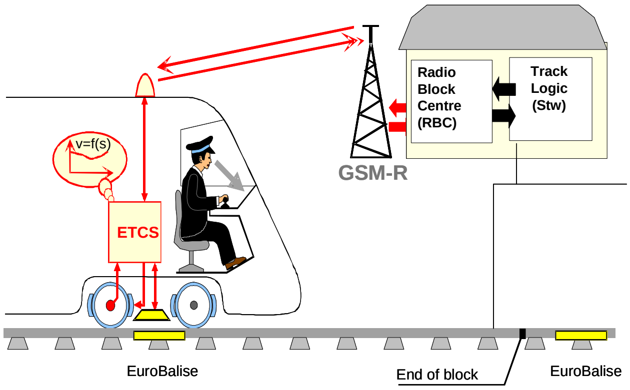


Figure B.1: Diagram of ETCS level 2

Communication between the on board ETCS unit and the Radio Block Centre is provided by the GSM-R platform.

Further specifics of ETCS level 2, see figure B.1, can be described as follows:

- The train spacing system is managed by the radio block which uses GSM-R as trackside-onboard communication system. The safety is hereby still controlled by the interlocking.
- The train position is evaluated onboard and calibrated by track fixed EuroBalises.
- The radio block centre receives the position report of the train and generates the unique track circuit occupancy.

The implementation of ETCS has various positive effects on higher safety: The train borne intelligent system often releases the train driver from a number of train control activities, consequently reducing the risk of human errors. The same system transmits the relevant control information to the train driver display and takes over automatic control functions (e.g. for speed control).

The display in the driver cabin shows speed information, supplementary driving information, planning and monitoring, see figure B.2.

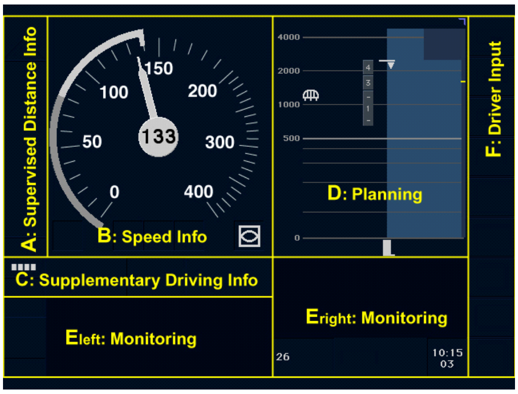


Figure B.2: Display for train driver

Based on digital train radio and new common signaling, train control and traffic coordination will reach a higher quality of rail business and a higher grade of safety.

See also clause A.2.4 for information on ETCS.

B.1.3 ERTMS

ETCS and train communication both form the basis for a traffic management system, which is the current goal of the standardized digital radio communication technology.

The traffic management system supports railway operation from the overall planning through to the driving of a single train at a specific point in time and place.

The machine driven intelligent planning would allow for total optimization of the network, optimal usage of electricity and other resources and maximum safety.

Train drivers could expect to get the optimal schedule and guidelines for their driving behavior. The guidelines are anticipating, which means, that they take into consideration the current operational situation and recent developments (e.g. building sites or crossing trains). Train drivers can strictly concentrate on following up the schedule which is being displayed to them on a man-machine-interface display on the train. The complexity of time table and scheme changes, signaling, special calls etc. can be reduced to the optimum. The automation of actions and activities brings less risk for human errors, less reaction time and more dependability.

Additionally the traffic management system contains a strong control system with control commands, which support train drivers in following up the schedule through automatic breaking and automatic speed control. E.g. when driving too fast for a certain period of time, the train will automatically initiate the breaking process to avoid traffic jams and therefore dangerous situations.

The European and interoperable aspects of these systems are plans for the future. The functional specifications are currently being worked out by European working groups.

To be able to start turning the ideas into reality, it was decided in Europe to start working on it through the implementation of ETCS and GSM-R as basis for European interoperability. The implementation is accepted by European law as it is a technology, which covers the main common needs, is the basis for interoperable and safe railway operations in the future. It can be implemented step by step and is well adjusted to the needs of every country through the various levels.

B.1.4 Additional GSM-R features critical for railway-specific functions and safety

A summary is given in figure B.3 of the additional features of GSM-R which are critical for railway specific functions and safety. Further details are given in the following clauses.

The additional features on GSM-R are critical for railway specific functions and safety

Die Bahn DB

Functional addressing	Location based addressing	Emergency call with priority handling	Group call
Functional based addressing enables operators to contact a train driver by calling a train number or a group (instead of a personal phone number)	Allows the train driver to address the controller responsible for line segment of the current location of the train	Priority treatment and repression of calls allows emergency calls to automatically free-up a slot on the network	A certain group of recipients, e.g. all train drivers on a specific train can be addressed at the same time

Figure B.3

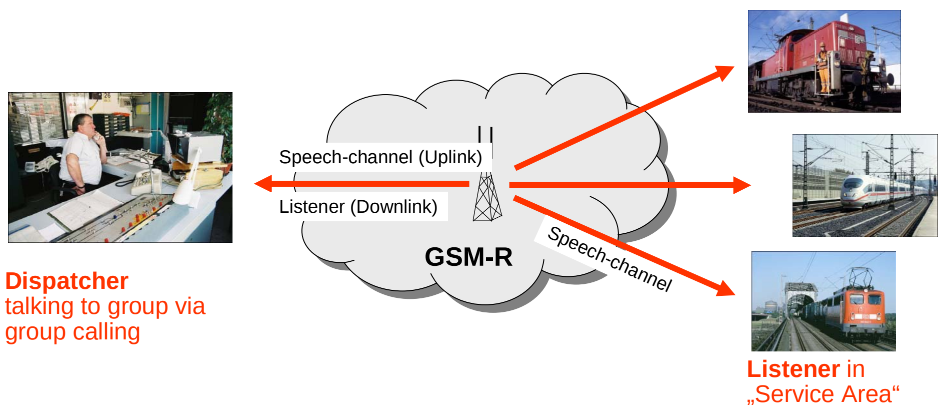
B.1.4.1 Group voice call / Functional Addressing

Voice Group Call, see figure B.4, is a service for transmitting information to one or more groups of subscribers in the GSM-R network simultaneously. In addition, individuals are not only reached under their telephone numbers, but also under a number that identifies their operational function within the railway system - this can be the terminal in the driver's cab or the traffic controller's GSM-R hand-held unit. The smart network within the GSM-R network therefore performs a "search" of the registered subscribers assigned the function called at that particular moment, see figure B.5.

Die Bahn DB

Enhanced speech features - Group call (VGCS)

The enhanced speech feature group call (VGCS) enables the dispatcher to talk to a number of mobile users simultaneously



Mobile group members share one speech-channel amongst all (Push-to-Talk-Taste)

Figure B.4

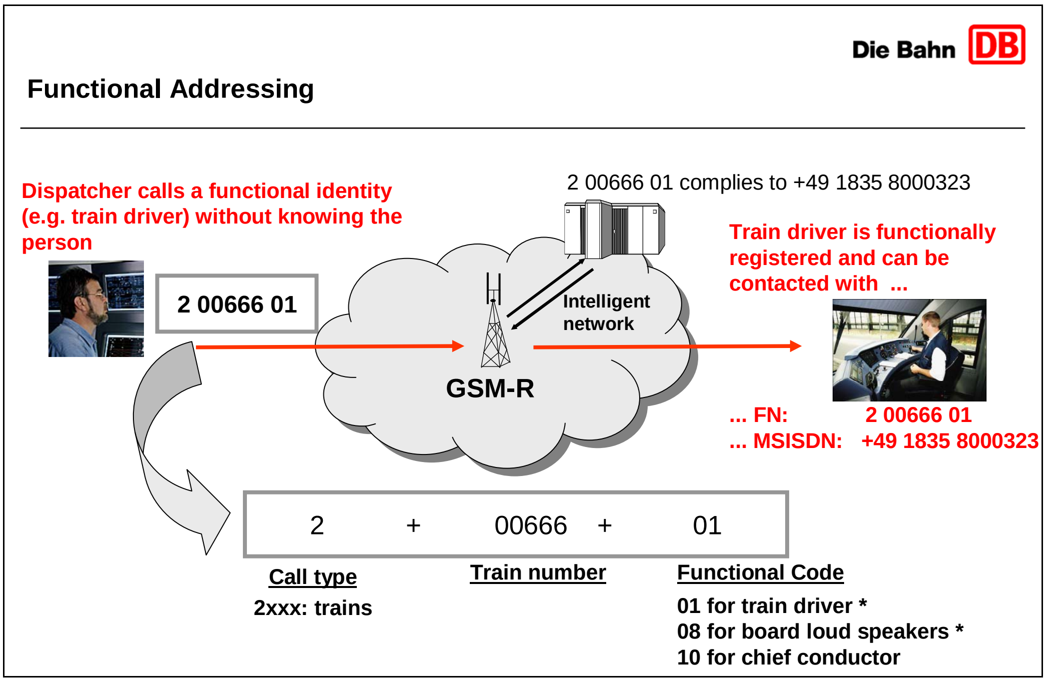


Figure B.5

B.1.4.2 Location dependent addressing

Location dependent addressing provides the automatic routing of Mobile Originated Calls to pre-defined destinations relative to the geographic area where the subscriber is roaming.

The entire network of railways is split into different types of service areas (train monitoring, train control, power supply, and substation). A train on a journey passes through several of these areas (e.g. train controller areas). The connection between a train driver and the controller of the respective area should be easy to establish. The train driver should have no need to dial long numbers after he has decided in which are he is actually driving.

Therefore, the train driver will only dial a short number as defined in the EIRENE numbering plan. This short number will be automatically converted into the corresponding long number(s) of the train controller(s) responsible for the area the train is actually moving trough. If a train is passing between two controller areas the connection will be made to both controllers.

B.1.4.3 Priority/ Pre-emption for voice and data calls

eMLPP (enhanced Multi-Level Precedence and Preemption):

The application ETCS has the need for a continuous data connection. If a handover to neighboring cells is unsuccessful due to congestion on the radio channel, a priority and pre-emption service is necessary to allow immediate access to a traffic channel occupied by a low priority application.

In every case Railway Emergency Calls have an immediate call setup in the relevant emergency call area with the highest priority. If no free radio channel in a radio cell is available, a pre-emption service will replace an ongoing call with lower priority.

Shunting Communication and Train Radio need different priorities then other types of communication. Therefore additional priority levels are required.

To introduce above mentioned functionalities into GSM-R eMLPP was specified in GSM Phase 2+.

B.1.4.4 Railway Emergency call

The digital radio system will also provide different priority levels for the individual calls: an emergency call - a special group call - has absolute priority over all other calls, see figure B.6. Each rail vehicle can be addressed via its current train number. Trains within the control of a regional authority can be reached by the traffic controller or another train as a group.

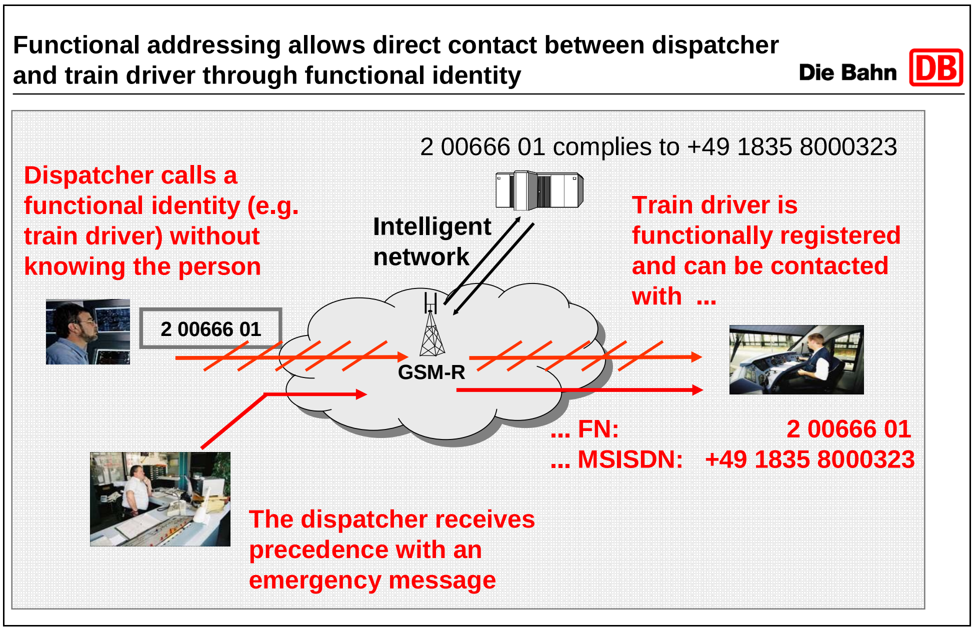


Figure B.6

B.2 Technical justification for spectrum

B.2.1 Determination of spectrum demand

- Complete coverage with high availability along the railway lines, railway stations and shunting areas see page 39 in [i.11]. **In urban agglomeration the coverage changes to a planar network for which the amount of required channels increases:**
- The radio network changes at the railway knots in urban centres into a planar network since the BS antennas cannot discriminate between the individual lines sharply enough anymore and cells start to create self-interference.

The relation shows (as a first approximation since not all natural numbers are valid) the planar networks requires about quadratic more channels compared with the line network along the railway tracks outside of these urban centres.

This can be seen in the equations 1 to 3:

$$\boxed{ClusterSize = FrequencyReuseFactor^2} \qquad (1)$$

Hence for a line network (2) and for a planar network (3)

$$\boxed{Required\,nb\,of\,channels\,per\,BS = \frac{Total\,nb\,of\,channels\,of\,the\,radio\,network}{FrequencyReuseFactor}} \qquad (2)$$

$$\text{Required nb of channels per BS} = \frac{\text{Total nb of channels of the radio network}}{\text{Cluster Size}} \quad (3)$$

Assuming a frequency reuse factor of 5, the cluster size becomes 25.Planning with adequate margins would mean that there are certainly more than 30 channels needed before only one single channel could be assigned to a BS.

Of course, some channels could be transferred from the individual lines, however, this will not be enough to provide a mean of 2 channels per BS. In case of only one channel per BS, the cell length along the railway lines is only half. The transmission capacity therefore will be reduced by needing more and more capacity for handovers such as in case of fast trains.

Hence, it can be concluded that in urban railway centres, the existing 19 channels is not sufficient.**The following determination of spectrum demand takes into account the above-mentioned requirements.**

The frequency reuse factor depends mainly on the percentage of receiving locations. For railways the EIRENE specification [i.11] requires a specified coverage probability. This means that in each location interval (length: 100 m) the measured coverage level has to be verified with a probability value of at least 95 %.

For radio network planning a value of 97 % is used. For the evaluation of the values the ITU-Recommendation P.370-7 [i.10] is used, as shown in figure B.7.

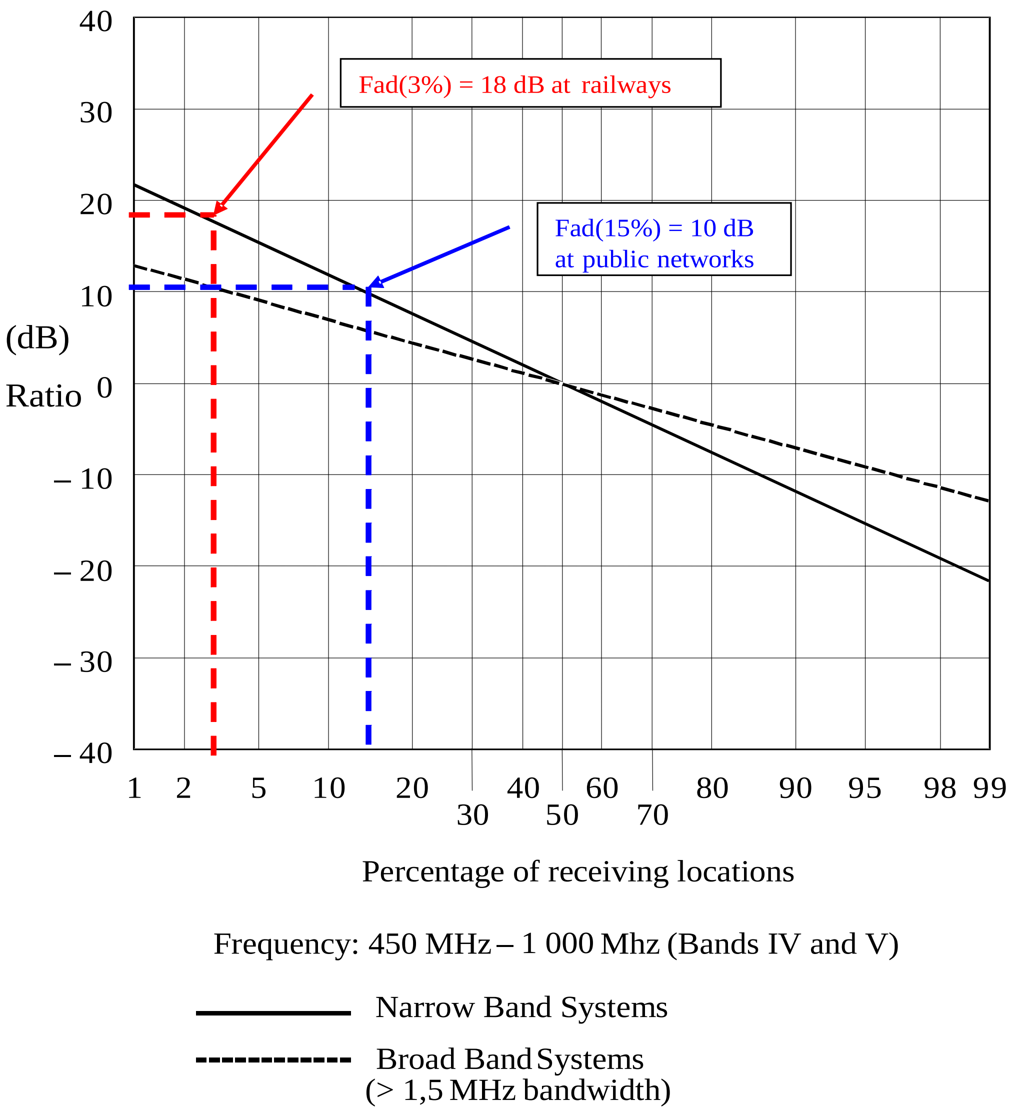


Figure B.7: Ratio (dB) of the field strength for a given percentage of the receiving locations to the field strength for 50 % of the receiving locations

A value of 97 % of probability is equal to a value of 3 % fading. The consequence of this is that an additional average margin of 18 dB is necessary. Taking into consideration this margin, the following equations are assumed:

Relation of fading, frequency reuse factor and data loss:

$$F = c - \gamma \cdot \log(d) \quad (4)$$

Calculation of the received signal strength depending on the distance and according to the attenuation per decade of the ITU diagram:

$$F_{car} - F_{Int} = c/i_{GSM\text{-}System} + \sum Fad_{(x\%)} = \gamma \cdot \log\left(\frac{d_{Int}}{d_{car}}\right) = \gamma \cdot \log(\text{Frequency reuse factor}) \quad (5)$$

and the frequency reuse factor is given by:

$$\text{Frequency reuse factor} = 10^{\frac{c/i_{GSM\text{-}System} + \sum Fad_{(x\%)}}{\gamma}} \quad (6)$$

$$\sum Fad_{(x\%)} = Fad_{(x\%)car} \text{ und } Fad_{(x\%)Int} = Fad_{(x\%)user/interferer} \cdot \sqrt{2} \quad (7)$$

Key to symbols used in the equations:

- F = field strength.
- F_{car} = field strength of wanted carrier.
- F_{Int} = field strength of interfering signal.
- c = constant, includes data of the BS such as transmit power and antenna characteristics.

γ = propagation coefficient (ref ITU curves for UHF, approximately 50 dB/decade of distance; up to values of 35 dB/decade of distance; the calculations below use 50 dB/decade).

d = distance.

$Fad_{(x\%)}$ = Fading (in dB); there is a relation to the probability of location and hence the data losses, expressed as a percentage.

ΣFad = Fading; single fading events of the wanted and unwanted signals.

$c/i_{GSM\text{-}System}$ = protection criteria of GSM = 9 dB.

For railway applications the specified coverage probability is 95 % - 98 %, which is equal to 2 % - 5 % of fading.

According to the formulas above, a frequency reuse factor of 4,3 - 5,2 is calculated:

- Case 1: C/I=9 dB; Fading 2 %, which is equal to 19 dB, γ=50 dB, the frequency reuse factor is calculated 5,24.
- Case 2: C/I=9 dB; Fading 5 %, which is equal to 16 dB, γ=50 dB, the frequency reuse factor is calculated 4,28.
- Case 3: C/I=9 dB; Fading 5 %, which is equal to 16 dB, γ=45 dB, the frequency reuse factor is calculated 5,04.

The calculations show that for a line orientated radio coverage it is necessary to have 5 independent frequencies with a system-defined spacing.

For the coverage of a planar network it is necessary to have 19 to 28 independent frequencies.

For radio network planning it has to be taken into consideration that in a GSM-R cell it could be possible to have a demand of more than one frequency for operational reasons:

- The density of railway traffic is high, for example in large railway stations or at railway crossings.

- The trains restart (re-setup) after a standstill and therefore there is a high demand of communication.
- Operational shunting in great shunting areas, where a secured radio communication has to be ensured.
- Coordination of the radio planning at national border lines and border railway stations between different countries.

Based on the average number of 1,5 frequencies per cell the demand of frequencies is:

28 - 42 GSM-R channels.

Taking into account the various aspects of radio planning, the average amount is 35 independent GSM-R frequencies.

This leads to a continuous frequency spectrum of minimum 7 MHz (duplex usage).

The conclusion is that in addition to the existing 4 MHz GSM-R spectrum which have already been assigned, another 3 MHz duplex spectrum need to be designated in the adjacent band, even when taking into account improvements of frequency efficiency (e.g. AMR, half rate codec).

The demand of additional frequencies was also the subject of a German expert's report from the CET (Consulting, Education and Training GmbH, Professor Dr.-Ing. K. Jobmann) [i.27]. The result of this report was a short term demand of another 10 GSM-R channels and an additional long term demand of 6 GSM-R channels resulting in a total sum of up to 16 channels.

Both considerations come to the conclusion that an additional spectrum of 15 GSM-R channels is necessary to ensure a safe, forward-looking and capable operational radio network for railway telecommunication.

A total additional spectrum requirement of 3 MHz duplex in the duplex frequency range 873 MHz to 876 MHz / 918 MHz to 921 MHz, adjacent to the currently designated spectrum 876 MHz to 880 MHz / 921 MHz to 925 MHz has been determined. In addition, it should be noted that GPRS usage for ETCS will only provide a relaxation in urban areas, in railway hubs it will not ease the frequency demand. GPRS for ETCS is currently under investigation, however, cannot be used before 2017-2019, although European-wide ETCS rollout already starts at 2013.

B.2.2 Power

Parameters are the same as in EN 301 502 [i.8] and EN 301 511 [i.9].

B.2.3 Bandwidth and other radio parameters

Parameters are the same as in EN 301 502 [i.8] and EN 301 511 [i.9].

Annex C: Expected sharing and compatibility issues

C.1 Existing allocations

The European table of allocations for the UHF frequency range of concern is as follows in table C.1:

Table C.1: excerpt from the European table of allocations [i.25]

870 MHz to 876 MHz paired with 915 MHz to 921 MHz	MOBILE Radiolocation (only in 915 MHz to 921 MHz on secondary basis)	Defence systems PMR/PAMR	There are no PMR/PAMR system implementations in this frequency band today.

C.2 Coexistence issues

The coexistence of 200 kHz wide air interfaces for implementation in the proposed 800MHz/900 MHz duplex band has already been studied extensively in several ECC Reports as listed below:

- CEPT ECC Report 34 [i.13]: "Compatibility between narrowband digital PMR/PAMR and tactical radio relay in the 900 MHz band, Cavtat, May 2003".
- CEPT Report 38 [i.14]: "Technical impact of introducing CDMA-PAMR on the UIC DMO & GSM-r radio systems in the 900 MHz band, Granada, February 2004".
- CEPT ECC Report 40 [i.15]: "Adjacent band compatibility between CDMA-PAMR mobile services and short range devices below 870 MHz, Granada, February 2004".
- CEPT ECC Report 41 [i.16]: "Adjacent Band Compatibility Between GSM AND CDMA-PAMR AT 915 MHz, Granada, February 2004".
- CEPT ECC Report 58 [i.17]: "Compatibility between TETRA RELEASE 2 TAPS and tactical radio relays in the 870-876 AND 915-921 MHz BANDS, Stockholm, October 2004".
- CEPT ECC Report 96 [i.18]: "Compatibility between UMTS 900/1800 and systems operating in adjacent bands, Krakow, March 2007".
- ECC Report 5 [i.20]: "Adjacent band compatibility between GSM and TETRA mobile services at 915 MHz".
- ECC Report 13 [i.21]: "Adjacent band compatibility between TETRA TAPS mobile services at 870 MHz".
- ECC Report 14 [i.22]:"Adjacent band compatibility of UIC Direct Mode with TETRA Advanced Packet Data Service (TAPS)".

Therefore, no new coexistence studies with regard to existing services have been identified or are considered to be necessary as a pre-condition for designating the additional GSM-RE spectrum.

New proposals for further applications and services (e.g. SRD or RFID) in the proposed frequency bands are proposed to be studied. However, the proposal in the present document is considered to be based on the existing ECC Reports stated above as well as ECC Decision (04)06 [i.6]. and therefore, new studies should focus on co-existence and sharing with GSM-R as a victim.

The approach could be to study the consequences from the embedding of other radio applications in the remaining "guardband", e.g. SRD and RFID applications.

For the purpose of studying, the shape of an optimized filter for GSM-RE operation (BS transmit side) is shown in figure C.1.

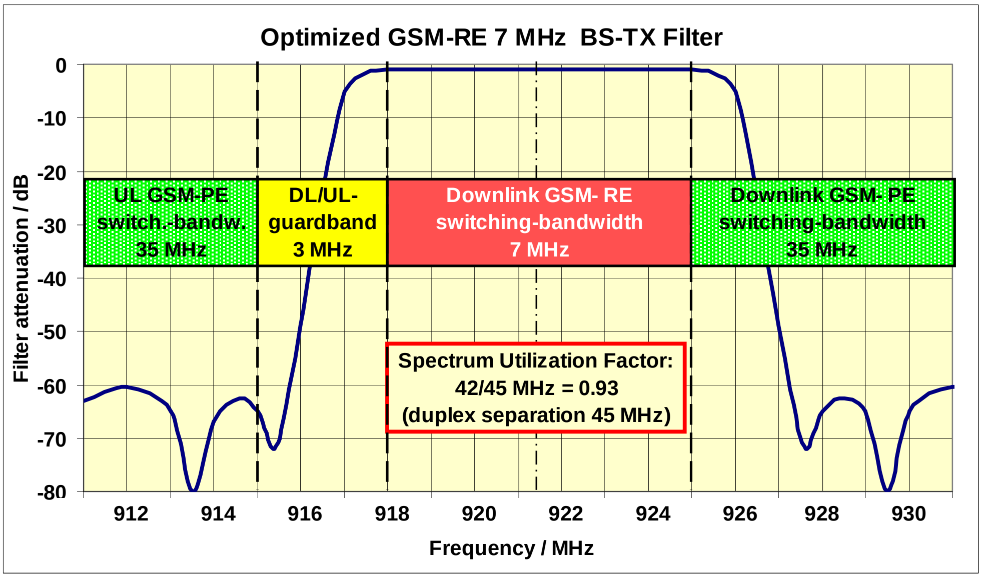


Figure C.1: Shape of a typical optimized GSM-R TX filter with 60 dB out band suppression

Due to the small remaining guardband of 3 MHz between GSM and GSM-RE, it is required that for GSM-RE base stations high-Q narrowband duplex-filters will be introduced as shown in figure C.1. The narrowband duplex filters submit the required safe operation of GSM-RE.

The embedding of secondary applications may be studied. However, it is proposed that these studies are not considered to be a pre-condition for the designation of the GSM-RE spectrum (as outlined above, all necessary studies are considered to be available). Today there could be three layers of services operating within the 900 MHz spectrum: GSM, GSM-R (including GSM-RE) and SRD/RFID. With this service-concentration a very high spectrum utilization factor could be achieved, even above the factor stated in figure C.1.

Co-frequency usage by secondary radio application and GSM-RE may be considered under the following conditions:

- An adequate Low Duty Cycle limitation for SRD application could be studied using the precedence case described in ECC Decision (06)12 [i.19], i.e. UWB LDC mitigation technique. In the case proposed in the present document, it would result in specific LDC limitations for the protection of the GSM-R radio communications service.
- Identification of the required minimum separation distance between GSM-R and the secondary embedded application as well as detect-and-avoid mechanisms may be considered. This may be used in case of RFID fixed installations under a controlled scenario (e.g. site notification procedure to ensure minimum distance to GSM-RE). Secondary, mobile (non-fixed) applications are proposed to be excluded under this scenario.

In this regard, draft TR 102 649-2 [i.24] containing a proposal for usage by SRD and RFID applications in this frequency band was considered when drafting the present document.

The required operational radio availability and quality of GSM-R and GSM-RE has to be noted.

GSM-R on contrary to public mobile GSM constitutes a non public network of the European Railways. GSM-R is a safety-relevant data service as designed for train-network management by command and control of train traffic up to very high speeds of 500 km/h as well as for corresponding speech communications. In spite of this basic service difference, the GSM-R air-interface is fully radio-compatible with the GSM-standard.

From the deployment point of view GSM-R is basically a line network along the Railway tracks. However, close to railway-traffic-nodes, the network density grows up to cover areas with cellular frequency reuse, caused by increasing traffic density. Anyway, command and control of a high number of mutually coordinated fast running trains require safe data transfer and highly reliable radio transmission.

Safety-relevant data transmissions for train-control require a sudden real time access and can not be transferred some time later as soon as the interference may have disappeared. Call success has to be close to a 100 % rate.

It is a fact, that for GSM-R statistical probabilities for call success are totally unsuited since each break by interference constitutes an inadmissible interruption of radio links which are determined for train control.

It should be noted that the operation conditions of GSM-R and the efforts for network planning are very different from public mobile GSM since the reliability of GSM-R is responsible for the safety of the Railway Customers, the transferred goods and the technical investments of Railway Administrations.

GSM-R and GSM-RE serve the same applications and need the same as above mentioned requirements.

C.3 Sharing issues

No new sharing issues with regard to existing applications and services that may need new spectrum engineering studies have been identified. New proposals for application in the proposed frequency bands may need to be studied for the exact sharing conditions.

The embedding of SRD/RFID applications in the remaining spectrum may require the introduction of small guardbands with regard to the proposed GSM-RE services. The remaining operational bandwidth for SRD/RFID applications should be identified as well as the exact technical requirements with regard to the sideband (out-of-band) emissions originating from SRD/RFID transmitters. This would possibly result in technical requirements such as on the maximum radiated emissions, maximum operating bandwidth and unwanted emissions. Furthermore, embedding close to GSM and GSM-RE may lead to consideration of requirements with regard to selectivity and blocking capability on the receive side of such secondary applications.

Annex D: Response of ETSI TC TETRA on plans for future use of the band by TETRA

TETRA31 (08) 21

European Telecommunications Standards Institute
TC TETRA#31
5-7th March 2008
Sophia Antipolis

To: ERM

From: TC TETRA Management Committee (MC)

Title: Liaison Statement (LS) Regarding Use of the 870 MHz to 876 MHz / 915 MHz to 921 MHz Frequency Band

Date: 25th March 2008

Dear Gabrielle,

We have no comments to the Draft SRdoc TR 102 649-2 RFID and SRDs in 870 MHz to 876 MHz and 915 MHz to 921 MHz as invited in your 14th March 2008 e-mail. However, we discussed this within the TC TETRA MC and we agreed it might be useful to provide an input to ERM explaining why we believe TETRA has not been deployed in this frequency band since it was first made available to TETRA in ERC Dec (96) 04.

The explanation as to why TETRA has not been deployed in this band falls into four main categories being:

- PMR Market.
- Market Forces.
- RF Propagation Characteristics.
- Technical.

PMR Market

The market for TETRA is primarily a replacement market for PMR user organizations that already use PMR networks operating in traditional PMR frequency bands, for example, VHF, 410 MHz to 430 MHz and 450 MHz to 470 MHz, with the exception of European Public Safety and Security (PSS) organizations that have allocated 2 x 5 MHz in the 380 MHz to 400 MHz band. Because of this, existing PMR users want to retain existing base station sites and utilize the same frequency bands to maintain the same RF coverage. As a consequence, the 870 MHz to 876/915 MHz to 921 MHz band is not required. Also, there are very few, if any, new PMR users that require medium to high capacity PMR networks, being the main requirement met by TETRA.

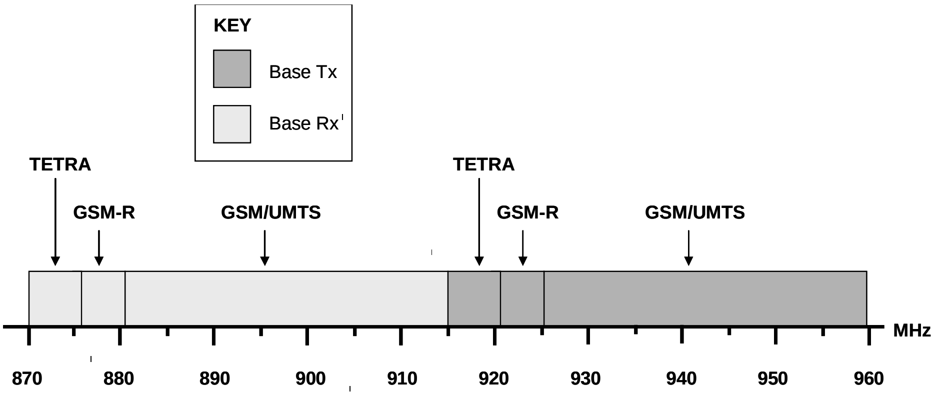
Market Forces

The market represented by the 870 MHz to 876/915 MHz to 921 MHz Frequency Band resides in Europe only. Also, because the useable spectrum is limited owing to interference (see technical clause below) the overall market, compared with the globally harmonized bands of 410 MHz to 430 MHz and 450 MHz to 470 MHz, combined with the 2 x 5 MHz allocated in the 380 MHz to 400 MHz band for European PSS organizations (largest market for TETRA to date), makes the market less attractive, hence the reason why no products have been deployed.

RF Propagation Characteristics

As the majority of TETRA networks utilize multiple base station sites to provide wide area coverage, using the 870 MHz to 876 MHz /915 MHz to 921 MHz band, instead of the 410 MHz to 430 MHz or the 450 MHz to 470 MHz band, would require a greater number of base station sites to provide the same RF coverage. This would be economically unacceptable, especially as most PMR user organizations own their PMR networks.

Technical



An important performance aspect of Mobile Stations (MSs) operating in any duplex band is their receiver selectivity. The chart below explains this in more detail.

As can be seen from the chart the spectrum directly above and below the 915 MHz to 921 MHz (BS to MS) band is used by wideband GSM-R and GSM/UMTS respectively and above the 870 MHz to 876 MHz (MS to BS) band by wideband GSM-R. As a consequence, the guard band required between narrow band TETRA and these wideband technologies reduces the amount of useable spectrum within the 876 MHz/915 MHz to 921 MHz band for TETRA, some estimates indicate as little as 2 x 3 MHz, especially as many traditional PMR user organizations require a high QoS and therefore cannot accept reduced RF coverage or loss of communications caused by interference.

Furthermore, Direct Mode Operation (DMO) in the 870 MHz to 876 MHz/915 MHz to 921 MHz band may also raise complex technical co-existence requirements.

Please note that the content of this LS is not meant to create any formal exchange between ERM and TC TETRA regarding the future use of the 870 MHz to 876 MHz/915 MHz to 921 MHz band but to simply explain why we believe TETRA has not been deployed in this band.

Sincere Regards

Doug Gray

Chairman TC TETRA

History

Document history		
V1.1.1	November 2008	Publication