GSM-R Key of Success - User Perspective

DB Netz AG

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GSM-R at DB Netz, presenting the experience of the largest GSM-R network in Europe

GSM-R is a well accepted and sucessful railway telecommunication system

Overview

- introduction of GSM-R in the DB Netz infrastructure
- actual status and figures of the DB Netz GSM-R network
- main applications used within GSM-R at DB Netz
- international roaming functions supported by GSM-R
- reinvest projects and future plans

The decision to start the GSM-R project was taken in 1998
The DB Netz GSM-R network became operational in 2004

Reasons for introduction of GSM-R at DB Netz

History

- 8 different analogue technical systems were used for train, shunting and track side communication
- end of lifetime reached for these systems

- maintenance of the analogue systems became expensive and technical support missing
- frequency licenses were limited until 2007 for analogue systems

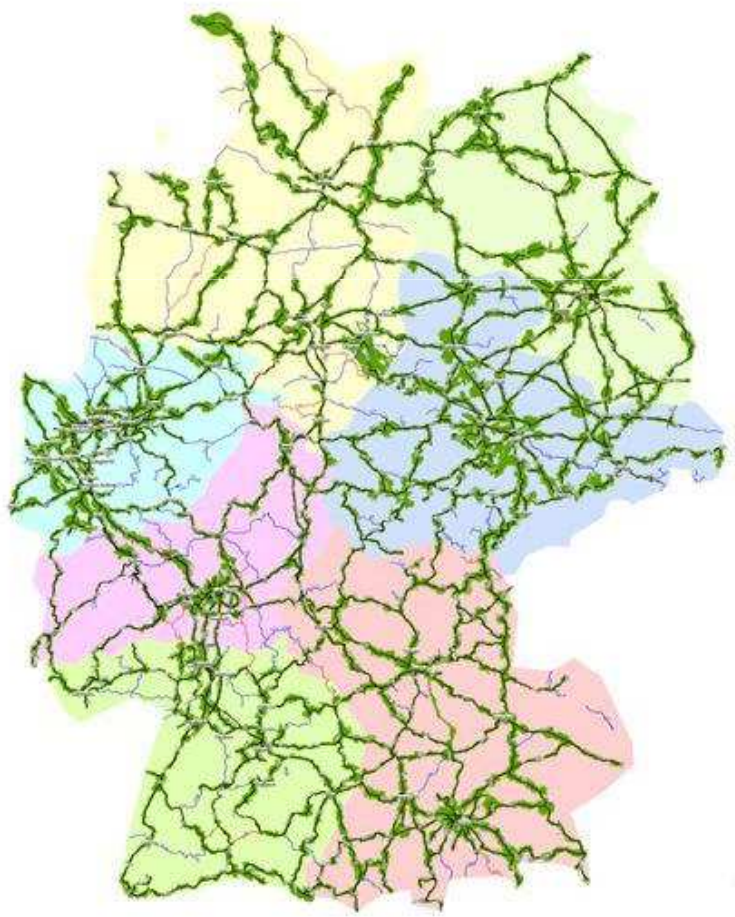
GSM-R

Decision to introduce GSM-R as one system for all railway communication applications

- ~24.300 km of track within the basic package
- ~5.000 km of track within the additional lines package
- ~ 1.400 shunting yards in the shunting project

Actually about 80% of the whole network of DB Netz are in operation with GSM-R

DB Netz GSM-R lines in operation



actual GSM-R network figures

- ~ 26.900 km GSM-R lines in operation
- ~ 2.400 km GSM-R lines in rollout
- ~ 2.300 km GSM-R lines in prepa-ration
- ~ 3.500 BTSs, 45 BSCs and 7 MSCs

actual GSM-R subscriber figures

- ~ 44.400 active SIM cards
  - ~ 16.400 Cab radios
    - ~ 400 EDORs
    - ~ 700 Modems
  - ~ 15.600 GPHs
    - ~ 8.100 OPHs
    - ~ 2.600 OPSs
    - ~ 600 mobile dispatchers
- ~ 3.400 fixed dispatchers (no SIM)

GSM-R is used as the single system for all types of railway communication applications

DB uses the following GSM-R applications

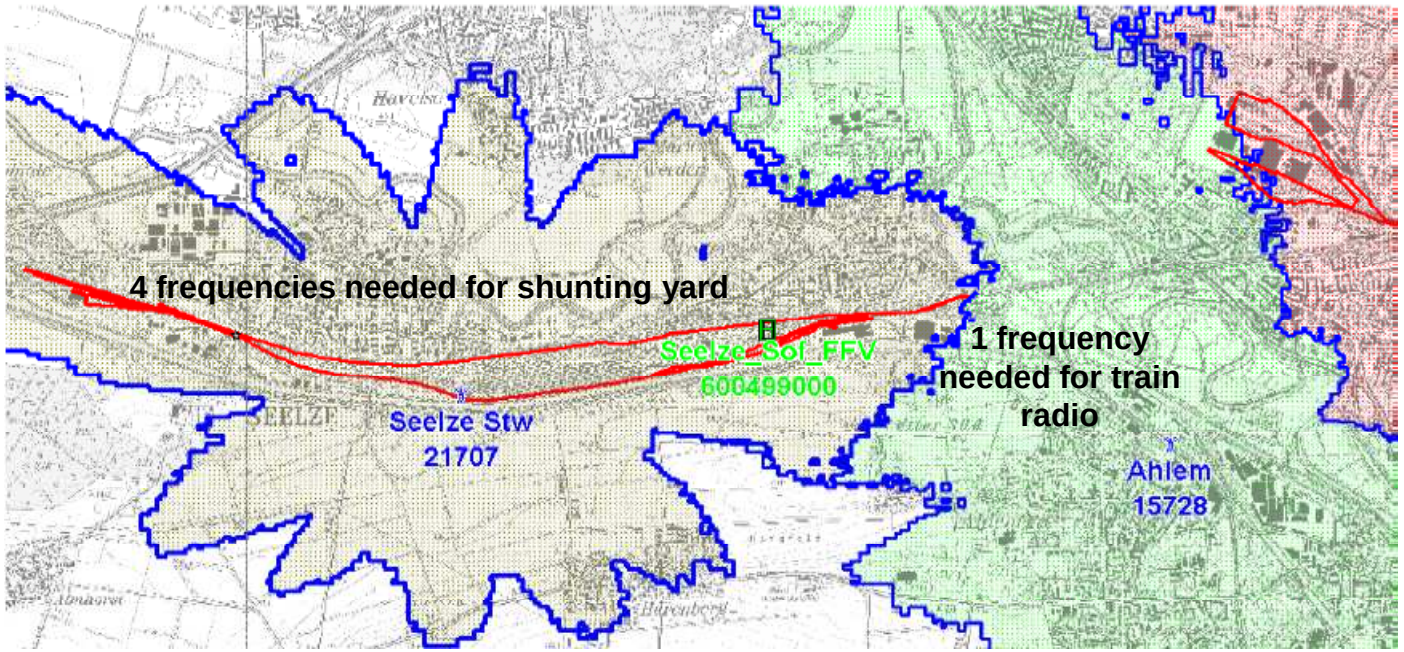
- train radio
- maintenance radio
- shunting radio including:
  - shunting with group calls
  - shunting with point to point calls in GSM-R
  - shunting with ptp calls in national roaming
- train approach indication calls between dispatchers
- data calls e.g.:
  - diagnostics of engines,
  - time tables for drivers
- ETCS calls:
  - first operational lines in level 2:
    - from Erfurt to Halle / Leipzig planned for end 2015
    - from Nuernberg to Erfurt planned for end 2017

GSM-R step by step replaces all analogue systems and offers additional functions and capacity

DB Netz uses GSM-R shunting with group calls, careful radio planning is essential for a proper working system

Shunting group call configurations including more than one radio cell shall be avoided

- necessary cell reselection radio processes cause voice transmission interruptions (below 1 second)
- configurations with more than one radio cell waste capacity



At DB Netz GSM-R shunting with group calls is well established
Training is important to adapt the habit of the users

DB Netz shunting yards

Shunting yard figures

- **1.304 are in operation with GSM-R or roaming**
- **1.395 are planned until end of 2014**

Training

the talker change radio process in GSM-R group calls requires a few milliseconds

the users need about 2 weeks to adopt to the habit in GSM-R group calls

„push – wait – talk“

Another main voice application of DB Netz is the train approach indication call between dispatchers and level crossing posts

Lineside telephony is replaced by GSM-R functions used in case of faults of technical secured level crossings

analogue System

copper wire

GSM-R

radio interconnection

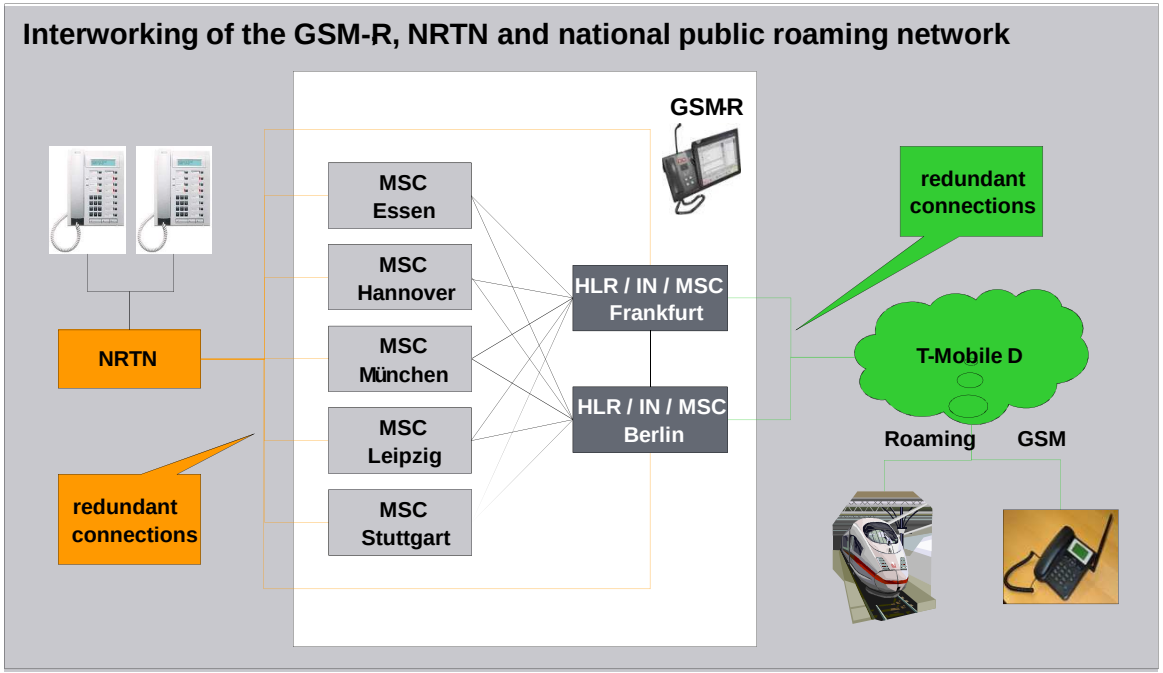
use of predefined conference calls including

- **train controllers (dispatchers)**
- **mobiles for posts registered to a functional address (Call Type 6)**
- **configuration of ~ 8.000 technically secured level crossings is in rollout**

National roaming is used as cost optimised fall back to increase the availability of GSM-R

GSM-R has become a precondition for railway operation, therefore the maximum possible availability of GSM-R is required

DB Netz fall back concept for GSM-R

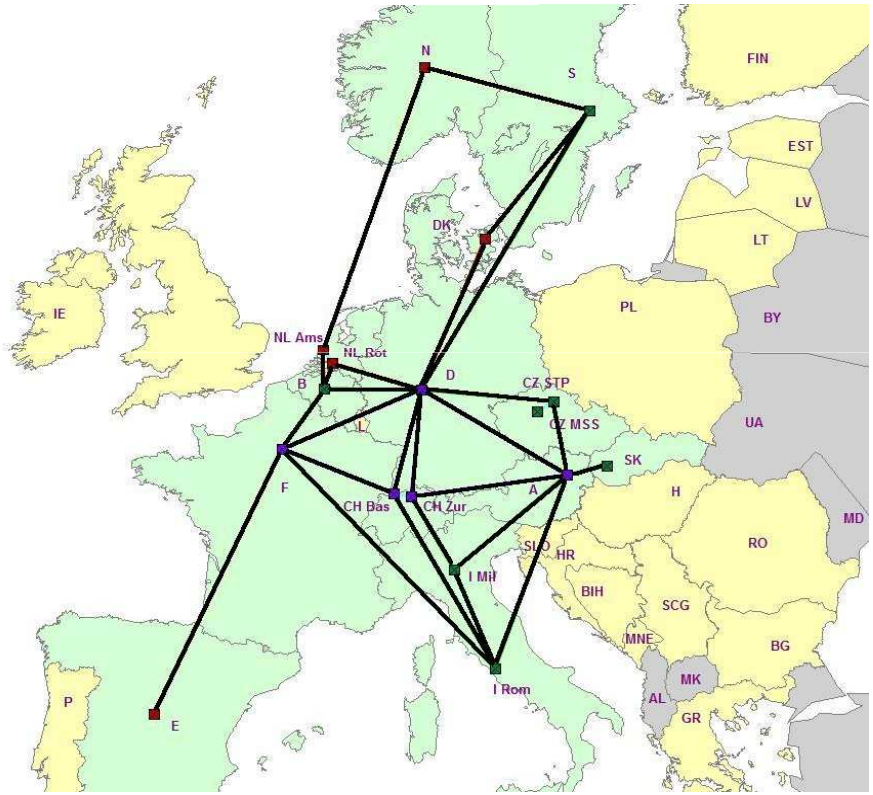


Solution

- train radios / mobiles use roaming in the Telekom D network
- dispatcher terminals have an assigned fall back phone with functional address
  - using either a public GSM office phone with a SIM from a special number range enabled to access GSM-R
  - or a NRTN office phone enabled to access GSM-R

GSM-R roaming is essential for the success of GSM-R and ERTMS in Europe

GSM-R Overlay network



ENIR GSM-R Overlay Network, international Interconnections latest design, activation Sept. 2013

Role of DB Netz

DB Netz is a central hub for the inter-national GSM-R overlay network and international GSM-R roaming

DB Netz actual figures:

- **9 operational interconnections to direct neighbour networks**
- **10 signed roaming agreements with partner GSM-R networks**
- **47 border crossing sites in operation with GSM-R**

DB Netz supports:

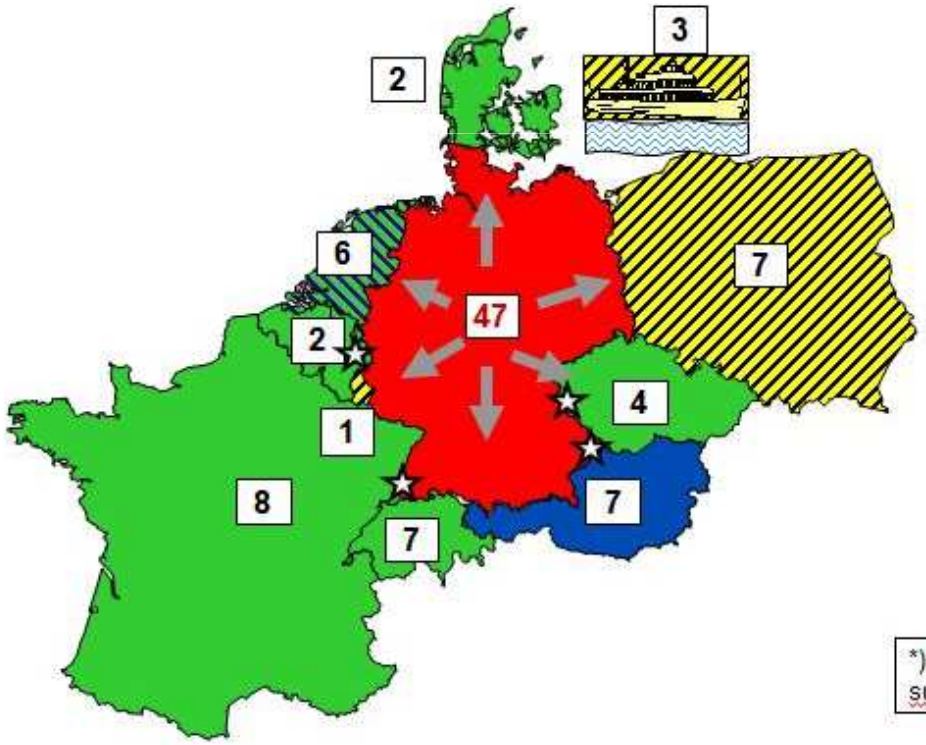
- **transit routing for all 13 partner networks in GSM-R overlay network**
- **use of public roaming as fallback solution for foreign roaming trains**

see later presentation on interconnection and roaming

DB Netz uses GSM-R at 47 out of 62 border crossing sites. BXGCA for internetwork railway emergency calls are introduced with Austria

DB Netz has 47 border crossing sites for international train traffic with GSM-R in operation

border crossing sites of DB Netz and neighbour networks



status	migration plan-ning of GSM-R	
	phase 3 used	GSM-R/ GSM-R with BXGCA*)
	phase 3 under investigation	GSM-R / GSM_R with BXGCA planned
	phase 2 finished	GSM-R / GSM-R
	Phase 1 for DB Netz	GSM-R / analogue radio or (-)
47	Border sites	with GSM-R
☆	BTS of DB Netz at neighbour site built or planned)	(Site-Sharing)

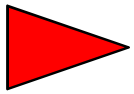
*) BXGCA = border crossing group call area (for support of internetwork REC)

Interferences from public networks hamper GSM-R usage
Assigned radio frequencies limit the GSM-R network capacity

The two main threats for the success of GSM-R

interference from public networks

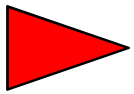
- the interferences caused by public networks are still increasing (actually 340 interferences since 2007 registered, thereof only 60 are solved)
- use of new technologies, e.g. broadband radio (LTE) and multicarrier BTS within public networks increase the risk of interferences



working group including DG-Move, ERA and UIC tries to solve this issue (see later presentation on interferences)

lack of network capacity due to limited assigned GSM-R frequency band

- due to a lack of capacity some large shunting yards in the DB Netz infrastructure have to use mixed GSM-R and analogue radio (0,7 m)
- ETCS using GSM-R circuit switched data services will cause a lack of capacity in high traffic areas



use of E-GSM-R band and ETCS over packet switched data (GPRS / EDGE) shall solve this issue (see later presentation on packet switch for ETCS)

Due to the early start of the GSM-R implementation components reach their end of life and have to be replaced

Reinvest projects modernize the DB Netz GSM-R network

BSC Reinvest Project

- finished in January 2013, migrated from 69 to 45 BSCs

MSC Reinvest Project

- migration from 7 MSCs to 2 MSC-Servers and 7 Mediagateways
- introducing the MSC-Server / Media Gateway (R4) architecture
- introducing the IP core network transport function
- start of field test and homologation in Q1 2015
- start of migration planned for end 2015
- end of migration planned for end 2016

BTS Reinvest Project

replacement of ~ 3.300 BTS

- introducing support for software defined radio functionality
- introducing support for multi technology radio systems
- preparation of tender offering started begin of 2013
- migration starts 2015
- following actual planning, migration ends 2023 due to exchange of huge number of BTS in the live network

preparing the path for introduction of the Future Railway Mobile Communication System (FRMCS)

DB actively supports the UIC project FRMCS (Future Railway Mobile Communication System)

Important aspects and goals for the definition of the FRMCS

GSM-R

from GSM-R systems with some railway specific functions

from specifc GSM-R mobiles (train radio, OPH, GPH)

FRMCS

to standard systems with railway applications on standard servers

to technical standard mobiles with railway specific apps

Functions inherited from modern mobile systems (e.g. LTE / SAE *)

*** Long Term Evolution, System Architecture Evolution**

- **multitechnological access networks**
- **software defined radio technology**
- **self organising network functionality**
- **all IP based network design**
- **infrastructure sharing functionality**
- **enhanced data traffic capacities**

Migration aspects

modern electronics enables multi technological mobiles that support FRMTS and GSM-R

migration strategy based on dual mode (FRMCS and GSM-R) mobiles is probably the only solution for international traffic

DB is well involved in the international GSM-R activities and actively supports the progress of European Railway Communication Systems (ERCS)

Name	International Engagement
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Rainer Eschlbeck	TSI OPE Group leader

Thank You for Your attention