GSM-R Key of Success - User Perspective
GSM-R at DB Netz, presenting the experience of the largest GSM-R network in Europe

GSM-R is a well accepted and successful 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

- 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

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

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

- ~ 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.

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

DB Netz AG | I.NVT21 Achim Vrielink

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
- GSM-R
  - copper wire

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**

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**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

Role of DB Netz

DB Netz is a central hub for the international 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

<table>
<thead>
<tr>
<th>Status</th>
<th>Migration Planning of GSM-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>phase 3 used</td>
<td>GSM-R/ GSM-R with BXGCA(*)</td>
</tr>
<tr>
<td>phase 3 under investigation</td>
<td>GSM-R / GSM-R with BXGCA planned</td>
</tr>
<tr>
<td>phase 2 finished</td>
<td>GSM-R / GSM-R</td>
</tr>
<tr>
<td>Phase 1 for DB Netz</td>
<td>GSM-R / analogue radio or (-)</td>
</tr>
<tr>
<td>47 Border sites</td>
<td>with GSM-R</td>
</tr>
<tr>
<td>BTS of DB Netz at neighbour site built or planned</td>
<td>(Site Sharing)</td>
</tr>
</tbody>
</table>

*) 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

<table>
<thead>
<tr>
<th>BSC Reinvest Project</th>
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<tr>
<td>finished in January 2013, migrated from 69 to 45 BSCs</td>
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<table>
<thead>
<tr>
<th>MSC Reinvest Project</th>
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<tbody>
<tr>
<td>migration from 7 MSCs to 2 MSC-Servers and 7 Mediagateways</td>
</tr>
<tr>
<td>introducing the MSC-Server / Media Gateway (R4) architecture</td>
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<tr>
<td>introducing the IP core network transport function</td>
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<tr>
<td>start of field test and homologation in Q1 2015</td>
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<tr>
<td>start of migration planned for end 2015</td>
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<td>end of migration planned for end 2016</td>
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<tr>
<th>BTS Reinvest Project</th>
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<tr>
<td>replacement of ~ 3.300 BTS</td>
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<tr>
<td>introducing support for software defined radio functionality</td>
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<tr>
<td>introducing support for multi technology radio systems</td>
</tr>
<tr>
<td>preparation of tender offering started begin of 2013</td>
</tr>
<tr>
<td>migration starts 2015</td>
</tr>
<tr>
<td>following actual planning, migration ends 2023 due to exchange of huge number of BTS in the live network</td>
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preparing the path for introduction of the Future Railway Mobile Communication System (FRMCS)
Important aspects and goals for the definition of the FRMCS

GSM-R
- from GSM-R systems with some railway specific functions
- from specific 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 multitechnological 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)

<table>
<thead>
<tr>
<th>Name</th>
<th>International Engagement</th>
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<tbody>
<tr>
<td>Achim Vrielink</td>
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<td>Holger Lietz</td>
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<td>Dirk Brucks</td>
<td>ENIR chairman</td>
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<td>Bernd Kampschulte</td>
<td>ENIR, NMG, FRMCS, PETER</td>
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<td>Dr. Reinhard Pospischil</td>
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<td>Klaus-Dieter Masur</td>
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<td>ETSI TC-RT task force E-GSMR leader</td>
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<tr>
<td>Rainer Eschlbeck</td>
<td>TSI OPE Group leader</td>
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Thank You for Your attention