GSM-R: Borderless Communication

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• The role of GSM-R in international train operation
• Roaming and interconnection
• Border Lines
• Network Management
• Future developments
The International Scope of GSM-R

Support of Railway Safety voice communication
- Driver – Controller
- Railway Emergency Calls
- Shunting communication

Support of ETCS Level 2 data communication
- Train (EVC) – Trackside (RBC) communication

It’s just normal that this works always for all trains, not only national trains, but also for visitors from abroad.

What’s the secret behind it?

GSM-R Interconnection network

UIC Conference 2013
Paris France
Example of interoperability

Italian Loco/Freighttrain on Corridor A under ETCS L2
Starting in Rotterdam
GSM-R Interoperability

Definition:
• GSM-R Interoperability is: network independent behavior of standardized onboard Voice and ETCS Data applications

So what’s needed:
• GSM-R network interconnection and roaming: Infrastructure Managers are suppliers of GSM-R communication services, providing at least mandatory EIRENE functionalities to all users, independent of their country of origin
• Users: Trains (with EIRENE compliant cabradio and ETCS modem) and handhelds, with GSM-R SIM cards
• This is only possible when GSM-R SIM cards are accepted in all GSM-R networks
• Roaming is prerequisite for Interoperability
Interconnection versus Roaming

Interconnection

- **Physical connection links** (2 Mbit/s lines) between national GSM-R networks, (forming our international GSM-R overlay network)
- Providing **Europe-wide interconnection** of all GSM-R networks with redundant routing paths for SS7 signaling and user data
- Bi-lateral **Interconnection Agreements** between Network Operators
- Multi-lateral **Transit Routing Agreement**, signed by everyone (!)
- **Needed for Roaming and border-crossing calls**, but also for fixed GSM-R communication, e.g. dispatcher-dispatcher communication on borderlines

Roaming

- Technical provisions and configurations in Networks in order to offer **communication services to GSM-R radio’s abroad** (= SIM card from other Network Operators)
- Bi-lateral **Roaming Agreements** between Network Operators
How does roaming work?

Call routing principle for international mobile terminated call (MTC)

1. Start of call set up, trunk seized
2. Call is routed to HPLMN, first interconnection trunk is seized
3. Send Routing Information (SRI)
4. Provide Roaming Number (PRN)
5. Result PRN
6. Result SRI
7. Call is routed back to VPLMN, second interconnection trunk is seized
8. Call is routed to visited MSC
9. Call is routed to roaming train

International GSM-R Overlay Network

SIM B

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ENIR GSM-R Overlay Network

- 13 railways interconnected
  A, B, CH, CZ, D, DK, E, F,
  I, N, NL, S, SK,
- 28 physical international GSM-R Interconnections
- Non-hierarchical network structure
- Fault tolerant routing schema for SS7 signaling and user data
- Update: once a year
- Latest design, activation with Routing Data Set (RDS) #9 at 22nd of Sept 2013

=> This network should be treated as a common international GSM-R network, needed to support our roaming facilities and cross-border calls!
The GSM-R Interconnection Network
Used fault tolerant routing schema

Example: End to end routing paths for calls from NL Rotterdam to Italy

Outage of interconnection NL Rot - D

=> Alternate routing path will be used:
   NL Rot – B – F – I Rom
# GSM-R Roaming

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**Operational**

**Ready for operation**

**Expected**

Source: NMG doc. N-9004
What if Roaming fails

Outage of MSC CZ (2010)
  – Due to flooding
  – Several days unavailable
  • Consequence: no roaming possible in Germany
    – International traffic D - CZ affected during at least 2 days
    – Loco’s with CZ SIM cards to be changed at borders
    – Massive delays

Outage of MSC NL (2009)
  – Due to planned work/upgrade activities
    – 20 minutes unavailable
  • Consequence: no roaming in D, F, BE, CH
    – Only 5 trains affected
    – Scheduled on 31/12/2009 at 23.00!
Dependencies

Interoperable Services
- Railway safety voice
- ETCS Data

GSM-R Coverage

Roaming Services

Interconnection Services
- capacity
- availability
- connectivity
- rollout-planning
- test-planning
- costs…

EIRENE functionality
- Quality of Service

EIRENE requirements
- Border crossing design
- Frequency coordination

Roaming Agreement
- Network Configuration

IC Network Layout
- Routing Configuration
- Transit Routing Agreement

Traffic Analysis
- Availability requirement
- Connectivity req.
Expansion of GSM-R Europe

- New networks added to the interconnection network, e.g.
  - Slovenia
  - Denmark
  - Portugal
  - Luxemburg
  - UK
  - Eastern Europe, Russia?

- New Roaming agreements
  - “Every SIM card supported in every country”
  - GPRS roaming
Future - Move to layered network structure

Challenge

Current network structure does not fit future requirements
• In many countries single Core (MSC/IN/etc) will be replaced by geo-redundant Core solutions -> almost double of network nodes
• Planned expansions by adding new countries to the interconnection network

Impact on interconnection network:
• Configuration Management for routing becomes too complex to handle
• Requested reliability and availability can’t be guaranteed
• Decrease of availability and risk of circular routing -> Roaming Outages!

Current: Non-hierarchical (layered)
international GSM-R overlay network
-> Routing gets too complex due to needed expansions of the network!
Layered approach

- Moving from a non-hierarchical network architecture to a hierarchical (layered) network architecture for SS7 signaling and traffic routing.
- Installing HUB functions in GSM-R interconnection network in order to connect multiple MSC networks.
- Optimize the interconnection network regarding routing straight forward via HUBs and multiple routing paths, load balancing, increase of availability, flexible expansions, etcetera.

Target (ideal): **Hierarchical** (layered) international GSM-R overlay network
Summary

Roaming and Interconnection is essential for Interoperability

- All operational GSM-R networks are interconnected by a well designed and managed interconnection network
- Roaming is active where needed (and more)
- Border crossing emergency calls are ready to implement
- Every international GSM-R service is covered by Roaming Agreements, Operation and Maintenance Agreements, Transit Routing Agreements, leading to an extremely high availability
- UIC coordinates by means of
  - NMG for legal matters
  - ENIR for technical issues
End of presentation

NMG / ENIR - connecting networks

Thank you for your attention

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