GSM-R Interconnection & Roaming situation, Future plans

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Content

- The International Scope of GSM-R
- Roaming and Interconnection
- International GSM-R
- Future Developments
GSM-R is the international platform for railway communication across borders

### Railway voice communication
- Driver – Controller communication
- Railway Emergency Calls (REC)
- Shunting communication

### ETCS data communication
- Train (OBU\(^{(1)}\)) – Trackside (RBC\(^{(2)}\)) communication

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These services are needed for all trains, national and international visitors from abroad

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\(^{(1)}\) Onboard Unit
\(^{(2)}\) Radio Block Centre
GSM-R Interoperability is network independent interworking of Voice and Data applications

**Items needed:**

**Network**
- Interconnected GSM-R networks and cross-border roaming services
- Infrastructure Managers as suppliers of GSM-R communication services
- Provisioning of mandatory EIRENE functionalities to all users, independent of their country of origin

**Users**
- EIRENE compliant cab radio
- ETCS modem (in trains)
- GSM-R handsets
  … all equipped with GSM-R SIM cards

**Framework**
- International agreements
- SIMs accepted in all GSM-R networks

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(1) GIRA - GSM-R Interconnection & Roaming Agreement,  (2) OMA - Operation & Maintenance Agreement,  (3) TRA - Transit Routing Agreement

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**Interconnection & roaming is prerequisite for interoperability**
Interconnection of the networks is the fundamental basis for GSM-R Roaming

Roaming (logical layer)
- Technical provisioning of services / SIM profiles
- Configuration of routing for roaming mobiles based on bi-lateral roaming agreements between network operators

Offers communication services to GSM-R radios abroad

Interconnection (physical layer)
- Physical interconnection links (2 Mbit/s lines) between national GSM-R networks
- European-wide interconnection of all GSM-R networks via transit routing forming our international GSM-R overlay network
- Redundant routing paths for control (SS7\(^{(1)}\)) & user (bearer) traffic
- Bi-lateral interconnection agreements (GIRA & OMA) between network operators
- Multi-lateral Transit Routing Agreement (TRA) valid for all interconnected networks

Allowing fixed GSM-R communication, e.g. Dispatcher-Disp. calls on borderlines

\(^{(1)}\) Signalling System number 7
The registration of the SIM-card follows the travelling train through the GSM-R networks

Example: Italian Loco / Freighttrain on Corridor A under ETCS L2 starting in Rotterdam

- SIM card
- ETCS OBU
- ETCS Radio
- VLR
- MSC
- RBC
- VLR
- MSC
- VLR
- HLR
- RBC
- RBC
- SIM IT

Notes:
1. VLR – Visitor Location Register
2. MSC – Mobile Switching Centre
3. HLR – Home Location Register
The international GSM-R overlay network is essential to support the roaming facilities and cross-border calls.

**International GSM-R overlay network**

**Actual structure**

**Details**

- Based on a non-hierarchical architecture
- 28 physical international GSM-R interconnections in operation
- Fault tolerant routing scheme for control (SS7) & user (bearer) traffic
- Latest design, activation with Routing Data Set (RDS) #9 at 22nd of September 2013
- 13 railways interconnected A, B, CH, CZ, D, DK, E, F, I, N, NL, S, SK
- Update: once a year -> new RDS
To ensure high reliability a fault tolerant routing scheme is implemented in the GSM-R overlay network.

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

Alternate routing path will be used automatically: NL(Rot) – B – F – I(Rom)
Actually are 27 GSM-R roaming services in operation

### NMG Document N-9004

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**Operational**

- Ready for operation
- Expected

**Notes**

- Expected for 2014
The scalability of the present non-hierarchical GSM-R network architecture is limited. It needs to be restructured.

Present: Non-hierarchical architecture

Additional nodes
- In many countries single gateway nodes will be replaced by geo-redundant solutions
  -> almost doubling of nodes
- Planned expansions by adding new countries / nodes to the interconnection network

Limiting factors
- Configuration management of routing becomes too complex to handle

Consequence
- Decrease of availability and reliability
- Risk of circular routing

Roaming outages!
To overcome the limitations, the overlay network will be restructured to a layered network architecture

**Approach**

- Moving from a non-hierarchical to a hierarchical (layered) network architecture
  - for control (SS7) and user (bearer) traffic routing
- Installing **hub** functions in GSM-R interconnection network in order to connect multiple GSM-R networks
- Optimize the routing strategy
  - straight forward via hubs and multiple routing paths
  - load balancing

**Result**

- Increase of availability and reliability
- Flexible expansions

**Target: Hierarchical architecture**
In future GSM-R networks and interconnections migrate to IP\(^{(1)}\)

**IP based interconnection network**

- Replacement of the existing circuit switched interconnection network
- Full support of GPRS\(^{(2)}\) cross-border
- Reduction of OPEX for interconnection (only IP based instead IP + CSD\(^{(3)}\))
- Higher data capabilities possible
- Prepared for the successor of GSM-R (technology independent)
- From separate physical network to shared virtual network

\(^{(1)}\) IP – Internet Protocol, \(^{(2)}\) GPRS – General Packet Radio Service, \(^{(3)}\) CSD – Circuit Switched Data
In the GSM-R world, Europe is already interconnected and interoperable

Interconnection and Roaming

- All operational GSM-R networks are interconnected by a well designed and managed interconnection network
- The restructuring to a layered interconnection network has started to guaranty requested flexibility, reliability and availability
- Roaming is active where needed
- Border crossing emergency calls are implemented
- Every international GSM-R service is covered by:
  - GIRA (GSM-R Interconnection & Roaming Agreement)
  - OMA (Operation & Maintenance Agreement)
  - TRA (Transit Routing Agreement)
- UIC coordinated
  - NMG for legal business
  - ENIR for technical matters
Thank you for your kind attention

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