“Implementation of GSM-R system on Slovenian Railways“
## Presentation agenda

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<td><strong>First phase</strong></td>
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The presenter...

Railway background:
- Started with Slovenian Railways 35 years ago
- Railway Operational Telecoms
- Involved with GSM-R in SLO since 2007

On Institute of Traffic and Transport Ljubljana since 2013
- Senior Researcher

International experience:
- Member of UIC ERIG
- Member of UIC Prequalification Group (PreQ)
- Chairmen of UIC Functional Group (FG)
Position in EU:

Relief overview:

Railway stations and train stops:

Railway lines:
**Statistical data and superlatives**

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
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<tr>
<td>Total length of lines:</td>
<td>1,207,701 km</td>
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<tr>
<td>Main lines:</td>
<td>606,379 km</td>
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<tr>
<td>Regional lines:</td>
<td>600,686 km</td>
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<tr>
<td>Double tracks:</td>
<td>333,539 km</td>
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<tr>
<td>Single tracks:</td>
<td>874,162 km</td>
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<tr>
<td>Electrified lines:</td>
<td>605.5 km</td>
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<tr>
<td>Rolling stocks:</td>
<td>260</td>
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<tr>
<td>The highest gradient:</td>
<td>26.7 promil</td>
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<tr>
<td>The highest railway station altitude:</td>
<td>582 m – station Postojna</td>
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<tr>
<td>The lowest railway station altitude:</td>
<td>3 m – station Koper</td>
</tr>
<tr>
<td>The longest bridge</td>
<td>575 m</td>
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<tr>
<td>The highest bridge</td>
<td>30 m</td>
</tr>
<tr>
<td>The longest tunnel</td>
<td>6327.3 m</td>
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<tr>
<td>The oldest railway line:</td>
<td>2nd of June 1846 Šentilj – Celje</td>
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**Milestones:**

Contract for preparation of documentation was signed in December of 2009.

Adopted decision from EC about co-financing – March 2013.

Contract with selected contractor for implementation was signed in August 2013.

Estimated date for completion of works is October 2016.

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<td></td>
<td>National Implementation Plan of TSI</td>
<td>Tender process for documentation preparation</td>
<td>Documentation preparation and tender process for implementation</td>
<td>Implementation of GSM-R network</td>
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<tr>
<td></td>
<td>6 years 6 months</td>
<td>3 years 4 months</td>
<td>Definition phase</td>
<td>Construction phase</td>
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The introduction of GSM-R system on Slovenian Railway network

- **Full range of technical solutions** for fixed and mobile communications, including infrastructure for Slovenian railways
- **Investor**: The Ministry of Infrastructure
- **Contractor**: Consortium Iskratel, GHH; GSM-R equipment supplier: Kapsch
- **Preparation of tender documents**: Slovenian Railways and SYSTRA SA France
- **Financing**: own funds and Cohesion funds
- **Implementation period**: 3 years
- **Average price per Km** of track include all WPs (without maintaining contract and VAT) is cca 110 KEUR / Km of line
Scope of works with financial structure:

The project is divided into six main Work Packages – WP

- WP1 Cabling
- WP2 Base stations
- WP3 Transport network SDH, IP
- WP4 Fixed dispatching system for GSM-R
- WP5 GSM-R infrastructure
- WP6 Mobile Terminals

Additional
- Training and Project management
- Spare parts, tools,
- Maintenance contract for 5 years
Key figures:

- **1200 km** of railways
- **132** railway stations
- **246** base station - BTS
- **110** Remote Radio Heads - RRH
- **2** MSC (geo redundant)
- **3** BSC (in redundant concept)
- **1** GPRS system
- **1** SMS center
- **1** centralized recording system
- **2** GSM-R Dispatcher Call Servers
- **75** compact Call Servers
- **211** dispatcher consoles
- **372** power supply systems
Work packages

WP1 – Cabling

- **Cca 900 km** of optical cables and **300 km** of power cables
- **Demanding design** mostly new cabling, smaller part of the re-used existing cables
- **Huge amount of construction work** (excavation, taking into account the geographical characteristics of the terrain)
Work packages

WP2 – Base stations

Construction works and equipment installation for BTS sites and technical rooms.

Construction works

 Installed equipment

RRH outdoor
WP3 – Transport network SDH, IP

- Based on SDH and Ethernet data transmission technology
- The integration into an existing network (TDM - E1,) for alternative routing
- The transport network across the main routes of transmission provides complete redundancy using a ring topology on separate physical connections
- Segment the network provides a high degree of control over traffic

Layer one (MSC / BSC connection) and layer two (BSC / BTS) example

Difference between main lines (double ring) and regional lines (single ring)
WP4 – Fixed dispatching system for GSM-R

• Solution supporting **modern (fixed and mobile)** and **legacy** technologies (LB, CB, analogue 2-w and 4-w trunks, announcement systems...) within a **single dispatcher terminal**.

• IP based architecture
  – centralized for parts where main GSM-R functionality is provided
  – decentralized where the locally connected lines have to be handled

• Dispatchers are connected over IP/Ethernet

• The communication system includes all the existing subscriber and transmission lines and enables communication with GSM-R mobile part, fixed system of ŽAT telephony, SMS services and central recording system.

• The layout is redundant – **geo-redundancy** at two locations in LJ and MB
WP5 – GSM-R infrastructure (core)

Next generation IP voice network solution based on the 3GPP Release 4 standards.
Network design/ planning / dimensioning/ confirmation and system integration of all main core systems:
- NSS Network Switching Subsystem
- BSS Base Station Subsystem (BSC with BTS-R)
- GPRS system
- SMS center
- Voice recording system
WP6 – GSM-R Mobile terminals

- **General purpose handhelds (GPH)** – 1,100 pcs
- **Operational purpose handhelds (OPH)** for field service staff – 370 pcs
- **Operational purpose handheld for shunting (OPS)** for staff participating in shunting works – 190 pcs
- **„Portable“ CAB radio** – 50 pcs

- **Heavy duty**
- **Main functionalities:**
  - Emergency call,
  - Push-to-Talk
  - SMS
Solution architecture

System connectivity
Redundancy concept

The SZ network is composed by two NSS in geo-redundant mode and three BSS which manage 1/3 of the BTSs each.

3 BSC redundant to each other

BTS loops and their connection to BSC

Dispatcher system in geo-redundant mode.
Radio coverage

Rx Level Diagram
According Eirene

Service Level

principle – single coverage

<table>
<thead>
<tr>
<th>required value</th>
<th>Results</th>
<th>Samples</th>
<th>Average</th>
<th>MAX</th>
<th>MIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ -95dBm @ 95% time &amp; space</td>
<td>100%</td>
<td>547</td>
<td>-62.52 dBm</td>
<td>-27.35 dBm</td>
<td>-89.29 dBm</td>
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Measured results better than required
Traffic Management Centers

In the Slovenian railway network we have three Traffic Management Centers shown on the picture bellow. For implementing LDA functionality we optimize the reselection zones between the different radio cells.
LDA functionalities

Radio cells allocated in the line (38 km)
Average distance between BTS’s in this section is 3,4 km

GSM-R network is designed to take into account the Slovenian railway operating program.

According to this plan, each cell will be attached to the specific primary controller or/and secondary controller.
Integration of existing analog telephony and GSM-R into ONE dispatcher platform
GSM-R applications based on GPRS packet switch will be implemented after the formal acceptance of GSM-R network.

Developing of this applications needs cooperation with IT sector as well as traffic operating staff.

We defined already some of them like:

- Ticketing
- Time tables on the train and for train drivers
- Departure documents for train driver (order for departure)
- Sending data from counters for electrical consuming on the locomotives

Early detection of danger situations on the railway lines and around with:

- Fire detection with sensors installed on the GSM-R masts
- Flood detection
- Landslide detection

Gathering all this information on the same platform for supporting the staff in dispatcher centers for quick and correct response and action.
End of presentation:

Thank you for your attention

Boris Gombač  Slovenian Railways
UIC FG chairman
boris.gombac@slo-zeleznice.si