Next generation and Shift2Rail
We are innovative
Introduction

Service and functional user requirements

Market evolution & industry direction

Stakeholder interests

Future Railway Communication System

Future deployment

Operating models

Resource availability constraints

ETSI standardization

3GPP specifications

Functional building blocks
Stakeholders and activities in Europe

Railway Undertakings Infrastructure Managers → FRMCS Project → Shift2Rail → TC RT / NG2R → Telecoms Industry

CEPT

CEPT

3GPP

NGTC

IN2Rail

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Shift²Rail & Horizon 2020

Excellent science

Industrial leadership

Societal challenges

EUR 77.000M ¹)

EUR 450M ¹)

EUR 6.339M ¹)

Smart, green and integrated transport

Train

Air

Road

Water-borne

Urban

Cross-cutting

¹) EU funding
**Shift²Rail Innovation Programmes**

**IP1:** Cost-efficient and reliable trains, including high capacity trains and high speed trains

**IP2:** Advanced traffic management & control systems

**IP3:** Cost efficient and reliable high capacity infrastructure

**IP4:** IT solutions for attractive railway services

**IP5:** Technologies for sustainable and attractive European rail freight

**Cross-cutting themes and activities**
Long-term needs and socio-economic research, smart materials and processes, system integration, safety and interoperability, energy and sustainability, human capital
### X2Rail-1 (36 Month)

<table>
<thead>
<tr>
<th>Year</th>
<th>Specification</th>
<th>Lab test</th>
<th>Field test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2017</td>
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<tr>
<td>2018</td>
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<td>2019</td>
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<td>2020</td>
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<td>2021</td>
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<td>2022</td>
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<tr>
<td>2023</td>
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</tbody>
</table>

### WP1 – Project management

- WP3: Adaptable communication system
- WP4: ATO over ETCS
- WP5: Moving block
- WP6: Zero on-site testing
- WP7: Smart wayside objects
- WP8: Cyber security

### WP2 – Technical coordination and system coherence

- WP9: Dissemination and communication
### TD2.1: Adaptable communications for all railways (quality of service, interfaces to signalling)

#### TD2.2: Railway network capacity increase (ATO up to GoA4 – UTO)

#### TD2.3: Moving block

#### TD2.4: Fail-safe train positioning (including satellite technology)

#### TD2.5: On-board train integrity

### TD2.6: Zero on-site testing (control command in lab demonstrators)

#### TD2.7: Formal methods and standardisation for smart signalling systems

#### TD2.8: Virtually – coupled train sets (VCTS)

#### TD2.9: Traffic management evolution

#### TD2.10: Smart radio-connected all-in-all wayside objects

### TD2.11: Cybersecurity
Shift²Rail members in IP2

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### Business & deployment models

**Railway communications as a service**
- Public mobile operators providing a service with a defined SLA

**Shared networks with similar user groups**
- PPDR, railways, public transport

**Shared subsystems**
- Shared spectrum vs. shared RAN vs. shared core network
  - Applications dedicated to railways

**Dedicated networks for railway communications**

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Solving the puzzle

FRMCS EIRENE Services
Interworking Co-Existence
Solution integration
Next generation radio
EPC IMS Core architecture
Critical communication enabler
Next generation system architecture

**Applications**
- Voice Services
- Data Services
- Group Communication
- Train Control
- Location Services
- M2M Services
- Video Services
- Others

**Core Network**
- GSM-R NSS
- IMS
- EPC
- Inter-working

**Access Network**
- GSM-R BSS
- LTE & 5G RAN
- WiFi
- Satellite
- Fixed Network IP based

**Terminal Equipment**
- CabRadio
- EDOR/OBU EVC/EuroRadio
- Handsets GPH/OPH/OPS
- Devices (AR, M2M, ..)
- Cameras CCTV
- Fixed Terminals
- Others

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Architectural approach

Comparison

Over-The-Top (OTT) vs. Common functionality and enabler framework based on relevant specifications vs. Application Silo

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Prototype development - Proof of Concept

Architectural and technical analysis

Proof of Concept & demos

Unified subscriber DB
One subscriber management system for GSM-R and next generation

IN service convergence
One service delivery platform for GSM-R and next generation, speaking to two worlds

REC for next generation
Evolving current GSM-R key functions (group calls, preemption, priority, CHPC)
Summary

- Monitor and contribute in the standardization bodies to drive the next generation definition

- Leverage internal study results and translate them into standardisation study/work items

- Contribute and lead European R&D programs around innovative rail product solutions

- Evolve existing product portfolio and source selected 3rd party subsystems for an integrated next generation solution

- Support our customers and maintain communication technology leadership for the future railway communication system

GSM-R support until 2030 and beyond!
Thank you for your attention

Andrei Vuta

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Adaptable communications for all railways

Overcome the shortcomings in current ETCS (European Train Control System) and CBTC (Communications-Based Train Control)

Adaptable communications system usable for train control applications in all market segments, using packet switching technologies (GPRS/EDGE, LTE, Satellite, Wi-Fi, etc.)

Enable a smooth migration from existing systems (e.g. GSM-R)

Stay resilient to interference and open to radio technology evolution

Provide enhanced throughput, safety and security functionalities to support today’s and future needs of railway operations & signaling systems

Support the shift from “network as an asset” to “network as a service” model vision
## Kapsch’s contribution

### TD2.1 – Adaptable communications for all railways (WP3 Leader)

<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 2.1.1</td>
<td>Analysis of user requirements and the assessment of feasibility in the light of the 3GPP and ETSI standardization work for future communication networks</td>
</tr>
<tr>
<td>Task 2.1.2</td>
<td>Contribution to the business model analysis and validation with the experience of public and private network implementation and operation models</td>
</tr>
<tr>
<td>Task 2.1.3</td>
<td>Research, analyse and enhance the required specification framework for the future communication system in line with the ongoing activities in 3GPP and ETSI TC RT. Feed findings, results and required enhancements back into 3GPP and ETSI TC RT for discussion and standardisation.</td>
</tr>
<tr>
<td>Task 2.1.5</td>
<td>Collaborate on the prototype development with Thales and others with focus on the development of functions and subsystems to support the EIRENE feature set within the future communication system. The development of the prototype will concentrate on the EIRENE railway emergency call application as it represent the complex combination of key EIRENE features (e.g. group communication, preemption and prioritization)</td>
</tr>
<tr>
<td>Task 2.1.6</td>
<td>Lab environment and on-site tests of the prototype to validate the capabilities of the selected technology and enablers</td>
</tr>
</tbody>
</table>
**Kapsch’s contribution**

### TD2.6 – Zero on-site testing (control command in lab demonstrators) (WP6)

<table>
<thead>
<tr>
<th>Problem assessment</th>
<th>Task 2.6.1: Contribute with assessment of the telecoms domain based on our experiences with customer projects and inter-vendor test campaigns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model definition</td>
<td>Task 2.6.2: For the definition of the test process our contribution will focus on the telecoms domain and the RAM (without safety, but with security) procedures and to contribute in the definition and implementation of methods to create, enhance and align test specifications and test results, based on the gained in multi-vendor test campaigns (NVIOT, TEN-T, etc.).</td>
</tr>
<tr>
<td>Environment specification</td>
<td>Task 2.6.3: Definition of a full end-to-end system environment with dedicated focus on the telecoms domain to increase the test coverage and maximise off site testing.</td>
</tr>
<tr>
<td>Interfaces &amp; protocols</td>
<td>Task 2.6.4: Analysis of interfaces or protocols in the communication layer which are mandatory in the end-to-end system, which ones have to be implemented in an test environment, which can be simulated and which shall be triggered by traffic generation.</td>
</tr>
<tr>
<td>Simulation</td>
<td>Task 2.6.5: The analysis and development of new enhanced simulation environments within the telecommunication domain, while leveraging our existing test systems and enriching our toolset with new functions, especially for the next generation communication system as defined by TD2.1</td>
</tr>
</tbody>
</table>
## Kapsch’s contribution

### Details

| Security system | Task 2.11.1: Contribution in the definition of a cyber-security system dedicated to railways with focus on the telecoms domain. Deliver the experience and findings from security related projects in railways and public operator projects. |
| Security methodology | Task 2.11.2: Application of the cyber-security methodology with focus on the telecoms domain in the light of the emerging new communication system defined in TD2.1 |
| Railway security experts | Task 2.11.3: Support the definition of scope, the setup and implementation of a network of railway cyber security experts (CERT) |
Spectrum discussions in Europe

400MHz Range
410-430/450-470 MHz

700MHz Range
698-703/753-758 MHz
733-736/788-791 MHz

UIC band
873 MHz
876-880 MHz
918 MHz
921-925 MHz

E-UIC band

PMR

PPDR

MFCN

IoT

SRD

2.6GHz TDD

3.4GHz / 3.6GHz
# Key technology characteristics

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Packet based communication</strong></td>
<td>Increased bandwidth, low latency, QoS enabled IP communication</td>
</tr>
<tr>
<td><strong>Bearer independent</strong></td>
<td>Core network, application and service logic independent from radio bearer</td>
</tr>
<tr>
<td><strong>Multi-Bearer support</strong></td>
<td>Co-existence, Inter-RAT hand-over and service transparency</td>
</tr>
<tr>
<td><strong>Adaptable, flexible and secure</strong></td>
<td>Leverage function virtualization, improve robustness, increase availability</td>
</tr>
</tbody>
</table>
Architectural considerations

Service enabler
- VoIP
- Preemption
- Location
- QoS
- Presence
- Group communication
- Security
- Policy
- Multi bearer
- Routing
- Proximity services

Core Network
- 3GPP eUTRA
- WiFi
- Satellite

Session control & management
- App.
- ETCS
- ATO
- REC
- FA / LDA
- App.
- ....

Terminals

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Activities in standardization bodies

ETSI TC RT / NG2R
System reference document TR 103 333

ETSI TC RT / NG2R
Use cases

3GPP SA1
FS_FRMCS

3GPP

3GPP

3GPP SA6
Implications to MCPTT specs

UIC
User Requirements Specification (URS)

UIC
System and functional architecture

ETSI TC RT / NG2R
System architecture study
(TR 103 459)

3GPP SA2