Shift2Rail: Innovations contributing to noise and vibration reduction

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S2R Joint Undertaking
S2R OBJECTIVES

+50%
INCREASE RELIABILITY & PUNCTUALITY BY 50%

x2
DOUBLE RAILWAY CAPACITY

HALVE LIFE-CYCLE COSTS OF RAILWAY TRANSPORTS

CONTRIBUTE TO REDUCTION OF NEGATIVE EXTERNALITIES, SUCH AS NOISE, VIBRATIONS, EMISSIONS & OTHER ENVIRONMENTAL IMPACTS

CONTRIBUTE TO THE ACHIEVEMENT OF THE SINGLE EUROPEAN RAILWAY AREA

S2R PROGRAMME, ABOUT €1BLN and A NEW APPROACH TO R&I IN RAILWAY

working together & driving innovation
AN OPEN and ACTIVE ORGANISATION

28 MEMBERS

375 PARTICIPANTS INVOLVED FROM 28 COUNTRIES

101 SMEs

103 RESEARCH CENTRES AND UNIVERSITIES

*Data extracted from CORDA database in February, 2019

Values as at 1 Sept 2016 in Million EUR

*incl. at least 120M€ of additional activities
...opening up new Capabilities coming from emerging technologies or concepts!
The S2R Programme implementation
R&I FOR INNOVATION CAPABILITIES

S2R PROGRAMME:
INTEGRATED
CONSISTENT
DELIVERY ORIENTED

Key Performance Indicators
- Long-term needs and socio-economic research
- System integration, safety and interoperability
- Energy and sustainability
- Human capital

Cost-efficient and Reliable Trains, including high-capacity trains and high-speed trains
Advanced Traffic Management & Control Systems
Cost-efficient, Sustainable and Reliable High Capacity Infrastructure
IT Solutions for Attractive Railway Services
Technologies for Sustainable & Attractive European Freight
S2R objectives on Noise & Vibration WA

N&V represent one of the biggest environmental challenges for the railway. The end result of this work area is to reduce the annoyance and exposure to noise and vibration related to the railway sector in Europe. To facilitate effective N&V management, it is crucial to apply an overall system approach and enable efficient mitigation actions.

- Develop practically useful methods for predicting noise and vibration performance on system level including both rolling stock infrastructure and its environment.
- With an accurate ranking and characterisation of each contributing source it will be possible to optimise cost benefit scenarios.
- Ensure that N&V needs are properly considered and integrated in all relevant Technology Demonstrators within the different S2R IPs

N&V mitigation contribute to strengthen the railway sector by improving passenger comfort and facilitating efficient product development.
Noise and vibration activities in S2R

Noise and Vibration
CCA WA 5.2
FINE-1 € 3 017 282
DESTINATE € 1 271 813

IP 1- TD 1.1 Traction
(PINTA, PINTA2)

IP 1- TD 1.2 Carbody
(PIVOT)

IP 1- TD 1.4 Running Gear
(PIVOT, RUN2RAIL)

IP 1- TD 1.5 Brakes
(PINTA, PIVOT, PINTA2)

IP 1- TD 1.6 Doors
(PIVOT)

IP 3- TD3.1 Enhanced S&C System
(IN2TRACK, IN2TRACK2)

IP 3- TD3.3 Optimized Track System
(IN2TRACK, IN2TRACK2)

IP 3- TD3.5 Proactive Bridge & Tunnel
Assessment, Repair and Upgrade
(IN2TRACK, IN2TRACK2, ASSETS4RAIL)

TD5.4 New Freight Propulsion Concepts
(DYNAFREIGHT, FFL4E, FR8RAIL II)

TD5.3 Smart Freight Wagon Concepts
(FR8RAIL, FR8RAIL II, INNOWAG)
Traction noise - Reduced tonality of motors with new technology

- Introduction of SiC converters in PINTA allows higher switching frequencies to be used (i.e., the rate at which the voltage is switched, pulsing DC to AC.)
- Higher switching frequencies reduces the tonal electromagnetic noise considerably.
Traction motor cooling noise

Before:
- Over-dimensioning of cooling fans
- Little design for noise at concept level

Now:
- Validated aero-acoustical CFD simulations
- Iterations and optimizations since concept
Traction motor cooling noise - simulations

Simulations match measurements very well
Good representation of spectra and directivity
Tested on two motors with different cooling architecture
Silent Wheelset

This new wheelset, provided with brake discs, will contribute to reduce noise emission.

- Lightweight solution, noise optimized wheels and an increased load capacity
- Will contribute to the modal shift from road to railway, by an increased freight transport volume
- This solution targets all the European freight wagons
- 2 dBA noise reduction in the wheel emission, fostering class A “very silent wagons“
- Reduced wear in the wheels, increased wheel life and LCC reduction
- Increased load per axle, from 22,5 to 25 Tn
CCA: Cross Cutting Activities

- Socio-Economics
- Safety, Standardisation and Smart Maintenance
- SMART Mobility
- KPI
- Energy and Sustainability
- Human Capital

Shift2Rail
The technology gives the possibility of listening and experiencing visually the noise of trains passing on a certain track, long before it is built.

Violeta Bulc, EU Commissioner for Transport, is testing the Auralisation at InnoTrans 2018.

Further examples: https://www.youtube.com/playlist?list=PLFHEzMwLXvjGY4KUMNR1PWGPWXj40jXnk
The auralisation system is based on synthesized signals and not on recorded signals as in earlier systems.

The technology was developed as interoperable on different media.
Cost-efficiency modelling tool for N&V mitigation measures

Cost benefit analysis to ex ante (control) or ex past (mitigation) interventions to reduce noise or vibration impacts in the neighborhood of railway activity

For the case of a residential area along a railway track:
• CBA helped to decide about preferred measures and how different parameters (vehicle composition, traffic intensity, speed, track geometry) may affect the results.
• how the benefits for the residents in terms of “savings” in the cost for health effects can be assessed and compared to the cost.

For some cases, it was found that there are limitations:
• Choices often refer to track measures rather than vehicle related measures, due to the number of vehicles to be treated,
• For depot noise the options for track related measures are limited,
• For interior noise, appropriate indicators for the passenger response need to be developed and validated. A first approach focuses on passenger appraisal.
S2R Europe 2030  Research and Innovation beyond 2020

**FUNDAMENTAL RESEARCH**
TRL: 0 -> 2
*Rail « Blue Sky »*
ad-hoc governance open to all

**APPLIED RESEARCH**
TRL: 3 -> 7
*R&I DEMO ERA authorization*
PPP membership with third parties

**DEPLOYMENT COORDINATION**
S2R solutions with S2R.JU supervision open to all

**START-UPS BLUE-SKY APPS**
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**Virtual Vehicle Austria consortium+ (VVAC+)**

**European Rail Operating community Consortium (EUROC)**

**Swi'Tracken consortium**

**Smart DeMain (SDM) consortium**

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