Europe's Rail link: https://rail-research.europa.eu/pages/fp2-r2dato/objectives

INTRODUCTION

Challenges and Needs of Railways Addressed by FP2-R2DATO

Achieving a modal shift requires public transport to be fast, efficient, environmentally friendly, decarbonized, accessible, affordable, reliable, widely available, modern, well-covered and integrated.

Increased capacity →bigger and smarter offer

Better punctuality, reliability and productivity of staff, rolling stock and infrastructure

Addressing the issue of the workforce shortage

Breaking interoperability barriers to facilitate the development of a fully integrated European railway network, enabling seamless travel across Europe

Challenges and Needs of Railways Addressed by FP2-R2DATO

Achieving a modal shift requires public transport to be fast, efficient, environmentally friendly, decarbonized, accessible, affordable, reliable, widely available, modern, well-covered and integrated.

Mobility users are increasingly making more conscious choices toward sustainable transportation

Rail is already a safe mode of transport but automation and digitalisation can further contribute to achieving the Zero Vision

Improving communication between the fleet, infrastructure, and other transport modes to deliver truly seamless and efficient travel.

What categories of KPI do we have?

EU Rail Project Implementation

- Aim: Monitoring project *progress* & GA *fulfillment*
- Examples:
  - % Punctual Deliverables
  - % WP fulfillment
  - No. of activities for Communication, Dissemination and Exploitation
- Part of the GA of **FP2-R2DATO**

Commercial Project Implementation

- Aim: Contractual condition in exploitation projects
- Examples:
  - Capacity, Reliability, Punctuality, etc …
- Best case / normally quantified
- Typically condition for Payment
- **Not applicable in Europe‘s Rail**

Impact of Results

- Aim: Prediction / Estimation of *technological* or *operational* impact of innovations if deployed
- Examples:
  - 10% increase of no. of trains per hour & dir.
  - 10% decrease in kWh consumption
  - 30% increase of productive hours of staff
- Part of the GA **of FP2-R2DATO**

Socio-Economic Impact

- Aim: Estimation of *socio-economic* impact of innovations once deployed
- Examples:
  - High level: Rail market share (passenger and freight)
  - Next level: Life cycle cost; rail attractiveness
- Part of the GA of **Academics4Rail**

Making our promises countable

Key Performance Indicators (KPI) addressed by FP2-R2DATO given in the Grant Agreement (GA):

Responsiveness: Reaction time on a request from Traffic Management System (TMS) (represented by FA1) to 2 Minutes (from 2 hours)

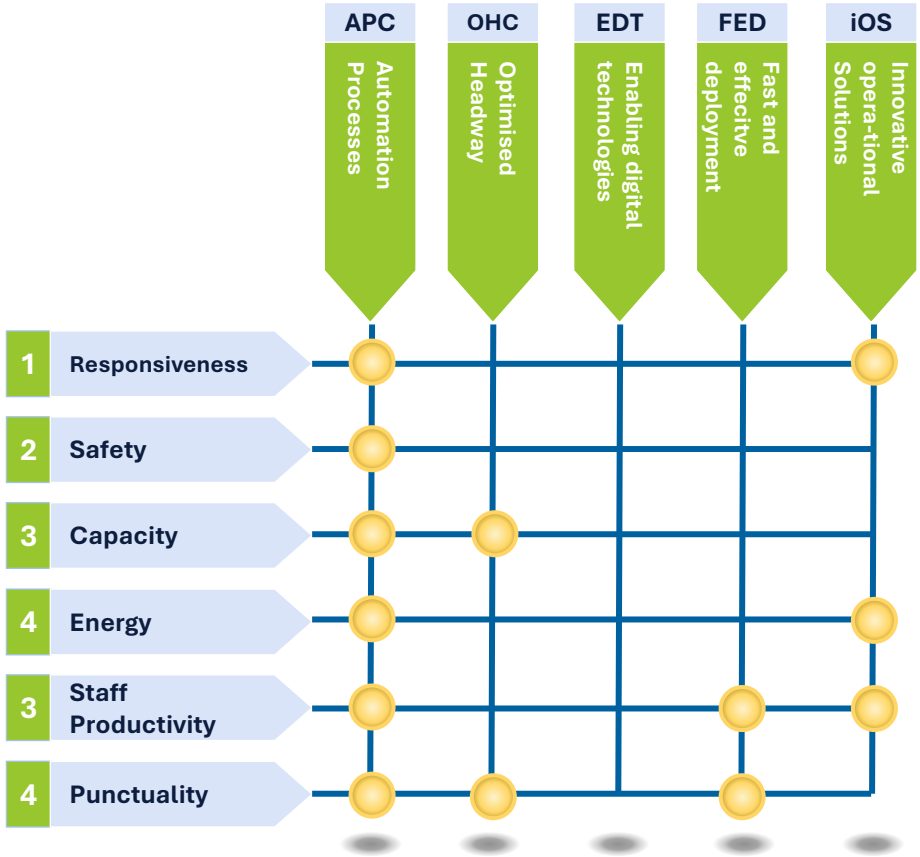
Safety: 50% decrease of no. of collisions with 3rd parties per 10.000 km travelled (ca. from 0.2 to 0.1)

Capacity: 10% Increase of no. of trains on a line per hour and direction

Energy: 10% decrease of energy consumption in kWh compared to human driver average

Staff productivity: 30% increase of productive hours

Punctuality: 50% decrease in delay Minutes



How to do this? - Approach

The expected Impact needs to be quantified and there needs to be a credible pathway to calculate them:

- (Note: “real” KPI can be measured, when a system is in operation)
- For estimating the impact there is a quantified baseline and a relative or absolute improvement value needed
- The approach in R2DATO is to use the demonstrators as source for baseline **and** improvement value, because:
    - Conditions are as identical as possible
    - Even if some impact factors are not known or quantified
    - They are “real world” values
    - They are reflecting highest possible Technology Readiness Levels (TRL)
- The target of the KPI calculation is to show the impact of R2DATO and show the positive benefits

FP2-R2DATO Project Overview

FP2-R2DATO in numbers

28
Partners

6 Clusters

48 WPs

588
Experts

202
Deliverables

28 Partners

FP2-R2DATO Partners

FP2-R2DATO partners together represent the railway sector in Europe :

Operators & Infrastructure managers

SNCF
DB BAHN
adif
FERROVIE DELLO STATO ITALIANE
ProRail
Jernbane-direktoratet
sporveien trikken
TRAFIKVERKET
ÖBB
SBB CFF FFS

Association

UITP ADVANCING PUBLIC TRANSPORT

Suppliers

ALSTOM · mobility by nature ·
CAF
Hitachi Rail STS
SIEMENS
AZD
COMSA CORPORACIÓN
KNORR-BREMSE
Faiveley Transport A Wabtec Company
kontron
mermec AN ANGEL COMPANY
GEOSAT
indra

Research Institutes

ceit
DLR

588 Experts

FP2-R2DATO Experts

FP2-R2DATO is composed of the best european experts on CCS (Command, Control, and Signalling) accross Europe with a rich variety of profiles:

Careers

- Researchers
- Managers
- Technical experts
- And many more...

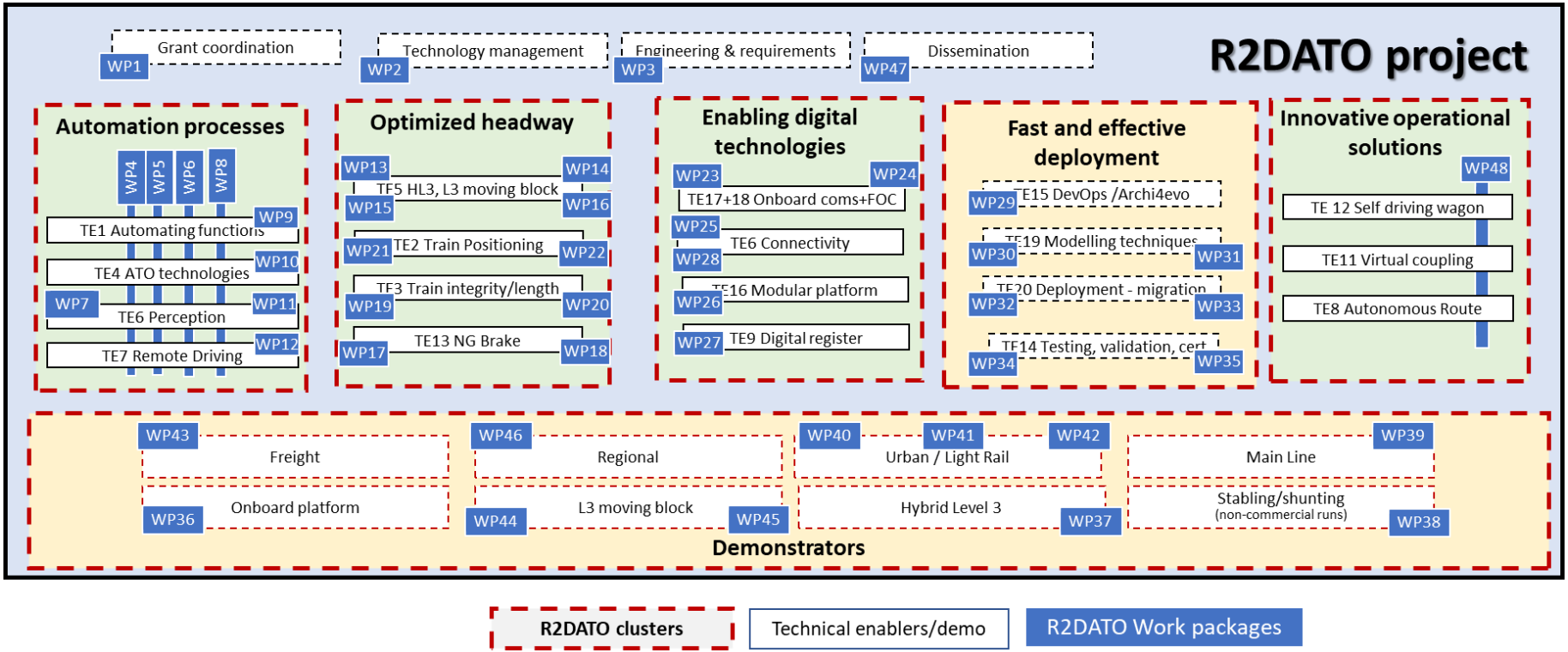
Skills

Area

6 Clusters
48 WPs

FP2-R2DATO Implementation Framework

FP2-R2DATO is composed of 6 clusters to manage the production of 48 Work Packages (WPs):



202 Deliverables

FP2-R2DATO Deliverables

FP2-R2DATO is producing 202 deliverables with a great variability of outputs:

15 Use Cases

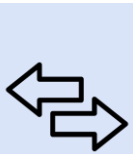
5 Simulations

13 Prototypes

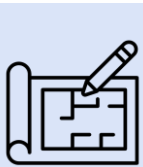
23 Demonstrators

2 Test benches

2 Business Case Analysis



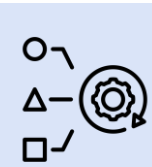
1 Migration Strategies



11 Architecture

29 Specifications

19 Requirements



Inputs to TSI
(Technical Specifications for Interoperability)

35 deliverables for CL1: Automation processes	34 for CL2: Optimized headway	27 for CL3: Enabling digital technologies	33 for CL4: Fast and effective deployment	55 for CL5: Demonstrators

FP2-R2DATO Clusters' Insights

6 Clusters
48 WPs

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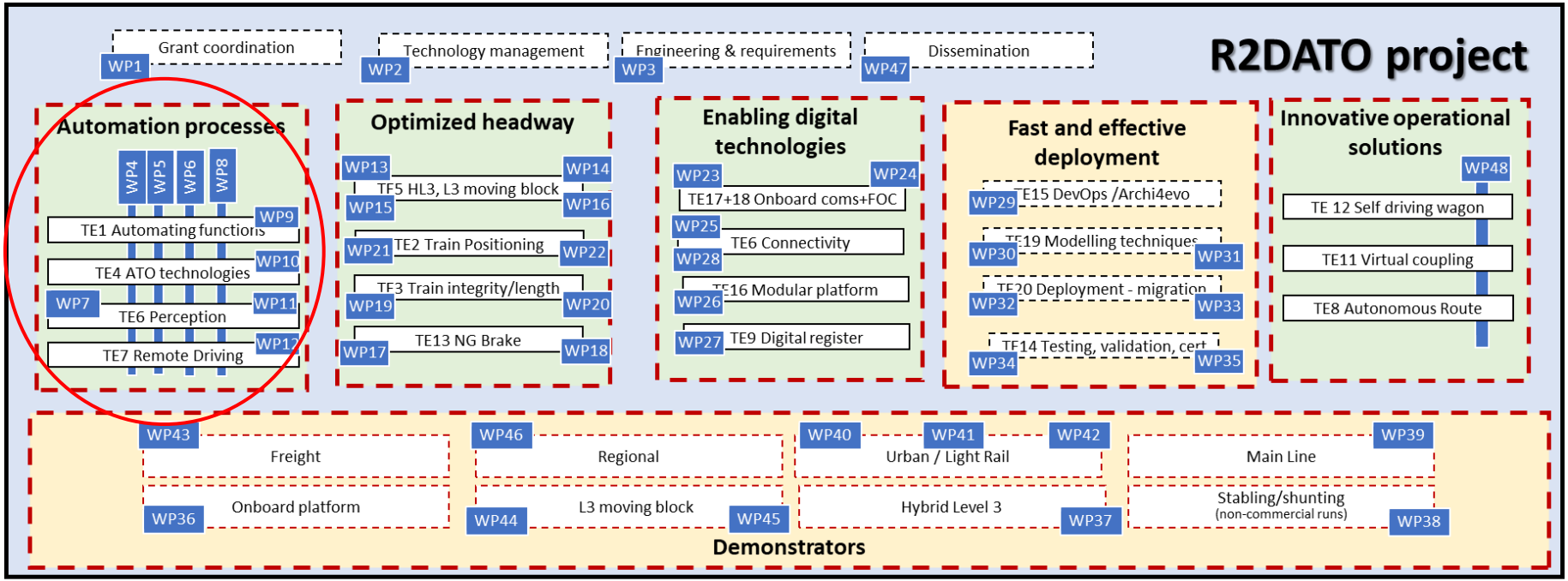


R2DATO clusters | Technical enablers/demo | R2DATO Work packages

APC : Automation Processes Cluster

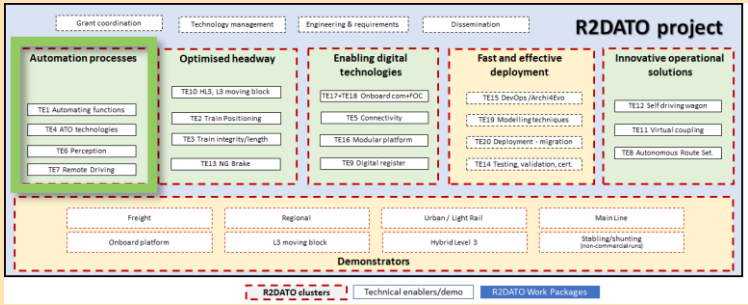
How is APC delivering impact ?

What are the challenges / painpoints we want to address ?

- High dependency of human factors in daily rail operations, leading to inefficiency and variable performance, leading to an unpredictable system
- Rather inflexible rail operations due to human resources management and long reaction times, also leading to poor overcoming of incidents, which may cause delays and cancellations.
- High number of non-productive operations in depots, for train preparation, and stabling requiring additional drivers and lowering productivity
- Complex urban light rail operations with multiple road users, and high workload for drivers, leading to frequent but many times avoidable incidents impairing service quality.

What are the goals, objectives of that topic ?

- To deliver scalable automation in rail operation up to GoA4 (Grade of Automation 4) for all segments, including freight and urban light rail.
- To implement operational solutions for automation up to GoA4 to be demonstrated in specific use cases through demonstrators and technical enablers.



APC : Automation Processes Cluster

What impact are we delivering ?

- Development of validated prototypes for different operational environments and uses cases of key **technical enablers** for automation, which are the **ATO technologies**, the **safe perception systems**, the **remote driving** and the **automating functions**.
- Collection of use cases and requirements and completeness of the architecture in collaboration with the System Pillar are previous steps leading to the development of building block prototypes and integrated demonstration, aiming to:
- Provide higher efficiency and flexibility to the railway system, enabling new operational approaches (e.g. on demand services) and optimising the available capacity.
- Reduce reactions times and increase resilience in case of accidents
- Improve overall productivity and reduce OPEX (OPerational EXpenses)
- Reduce the number of accidents in urban light rail operations, leading to reduce human fatalities or injuries and to increase of service reliability .

APC : Automation Processes Cluster

Towards demonstration

TRL4/5

TRL6/7

WP4
System View & Coordination

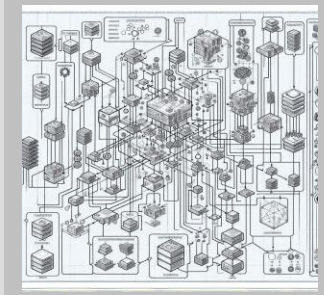
Needs

WP5
Use cases

Specifications

WP6
Specifications

WP8
Safety
Analysis



Development

WP7
Data Factory

WP9
Automating Functions Prototypes

WP10
ATO Prototypes

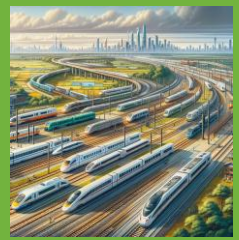
WP11
Perception Prototypes

WP12
Remote Driving Prototypes

Validation

Demonstration

Demonstrators



6 Clusters
48 WPs

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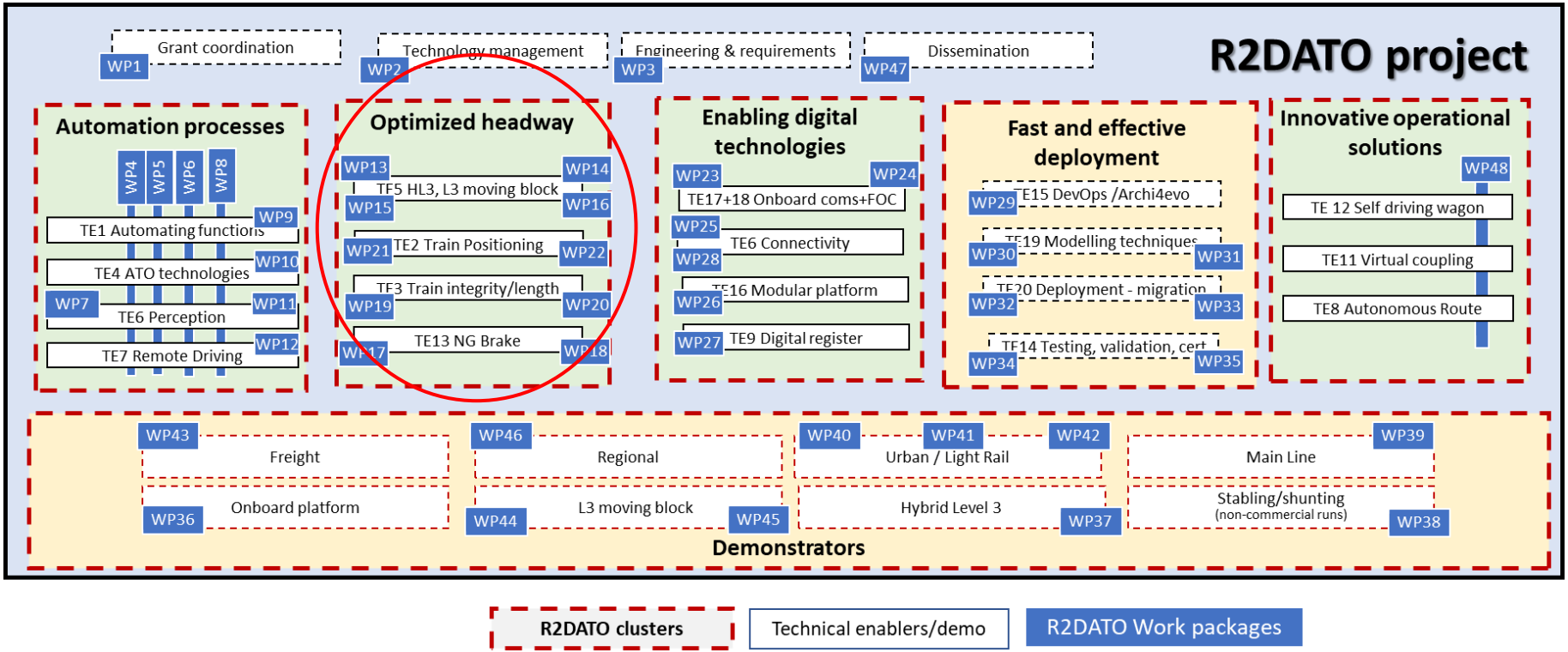


How is R2DATO delivering impact ?

What are the challenges/ pain points we want to address?

- **Increasing** operational **capacity** on current infrastructure.
- **Reducing operational/life cycle costs** by ETCS (European Train Control System) Hybrid Level 3,
- **Enabling ETCS Level 3 Moving Block** with new train positioning technologies.
- Achieving **reproducible braking distances** / improved braking performance.

What are the goals, objectives of that topic?

- **Use cases**, **requirements** and compilation of the system **architecture** in collaboration with the System Pillar and WP3 as steps leading towards the **development** of prototypes and integrated demonstration.
- The **validation of prototypes** ready to demonstrate the ERTMS game changers in different **operational environments**, with:
  - mixed radio based ETCS levels with Hybrid Level 3, ETCS L3 moving block,
  - absolute train position, train integrity and train length management,
  - optimised and reproducible braking performance.

Cluster 2: OHW
Optimized Headway

What impact are we delivering?

- **Capacity and stability increase,** verified by:
  - determination of **punctuality figures**,
  - **headways** and travel times based on data gained from test runs in the demonstration phase,
  - application of **simulation tools** for getting the whole network perspective.
- **Improve the robustness** of the system with the increased capacity having positive impact on the potential to **compensate disturbances**.

How does it contribute to our KPIs?

Capacity

- **KPI 3, capacity:**
  increase of number of trains on railway track per hour and direction.

Punctuality

- **KPI 6, punctuality:**
  significant decrease of delay times.

cluster 2 [OHW] – optimized headway

overview on MB [WP13|14] & HL3|HTD [WP15|16]

objectives of the technical enabler [TE]

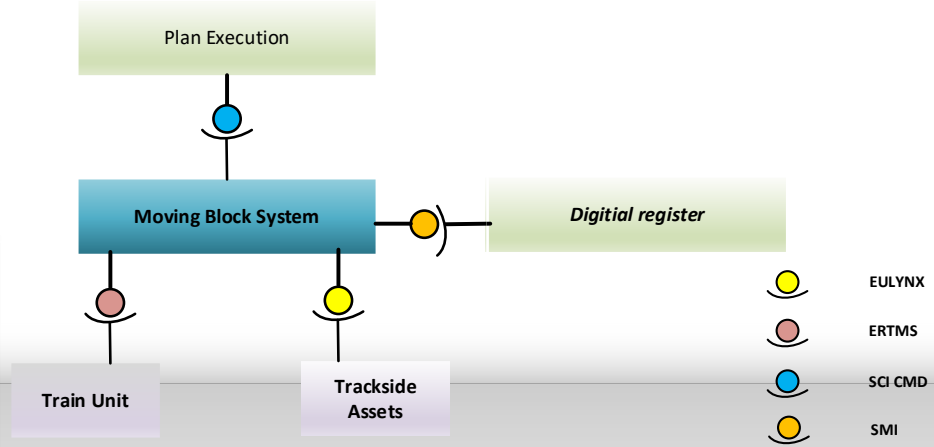
- to specify and define concepts of a high capacity signalling System
- to align the architecture and requirements with the involved stakeholders
- to support the maturity of the specification by demonstrators

challenges:

to align with involved stakeholders

Milestones of the technical enabler [TE]

- 3 Moving Block Specifications released and corresponding implementations designed, developed and delivered to the demonstrator WP
- Specifications for HTD released, to be used in the demonstrators



6 Clusters
48 WPs

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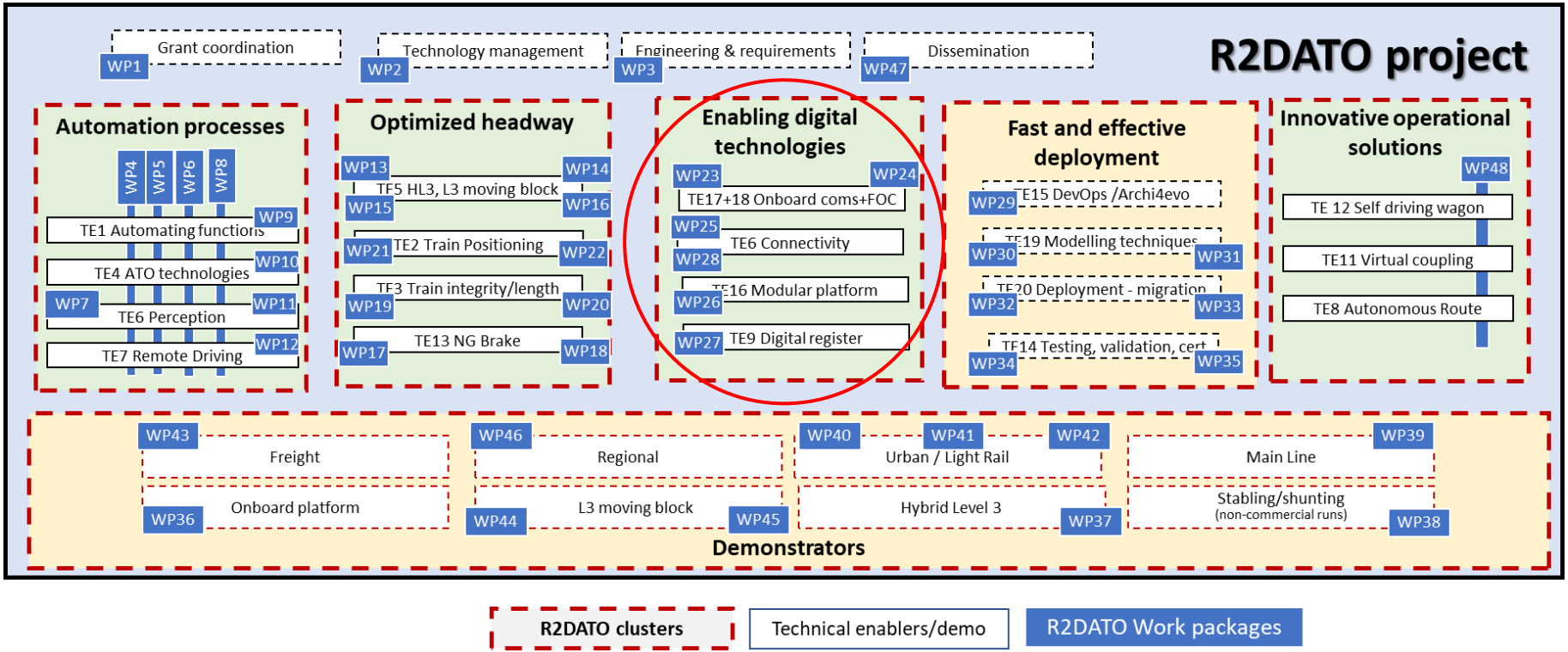


How is EDT delivering impact ?

What are the challenges / painpoints we want to adress ?

- Development of foundations for onboard network communication
- Definition of CCS (Common Components System)/TCMS interoperability (Train Control and Monitoring System)
- Further specification work for FRMCS (Focus Onboard-System and Trackside Gateway)
- The specification of Computing Platforms is crucial to support modular certification and efficient and interchangeable deployment of safe and basic integrity railway applications
- Developing the architecture and specifications for the implementation, testing and certification of Specification, development, and implementation of the Digital Register in the sense of a database supporting assisted and automated train operations
- Investigate how multiple radio bearers can be used concurrently to serve the needs of both the Gigabit train and future rail operations, and how the FRMCS architecture and specifications can potentially be expanded in this direction

What are the goals, objectives of that topic ?

"To achieve substantial progress in specification work, establishing a solid foundation for future demos."

- Deliver input for TSI2025 update, SS 147 V. 2.0 (common bus)
- Specifiaction of interface between FRMCS (Future Railway Mobile Communications System) and ATO (Automatic Train Operation)
- Provide specifications for modular platforms
- Further develop specifications for the digital register

5 → **Demonstrators are supported by work of the EDT cluster**

How is EDT delivering impact ?

What impact are we delivering ?

Standardization topics:

- Standardisation of Computing Environment
- Configuration management
- Data interface between DR and CCS/TMS Components (Phase 1)
- Data interface between DR and CCS/TMS Components (Phase 2)

1

TSI Update planned from Enabling Digital Technologies Cluster

4

Standardisation Requests from Enabling Digital Technologies Cluster

- Update of Subset 147 V2.0 is included in the standardization roadmap of EU-Rail, with plans for inclusion in future TSI change request process

How does it contribute to our KPIs ?

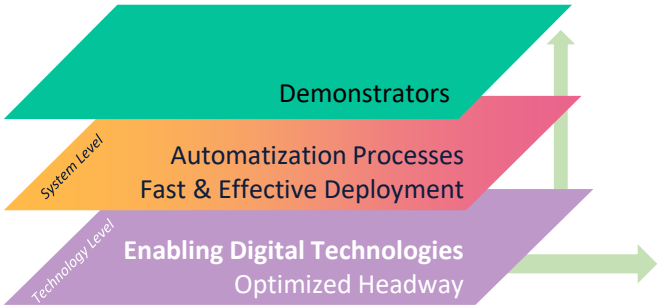
- Development of Digital Technologies that enable the performance of the solution
- Enabling the Clusters *Automation Processes* and *Optimized Headway* to reach project KPIs that are well defined and measured in the Demonstrators Cluster

DR: Digital Register
CCS: Common Components System
TMS: Traffic Management System

Enabling Digital Technologies Cluster

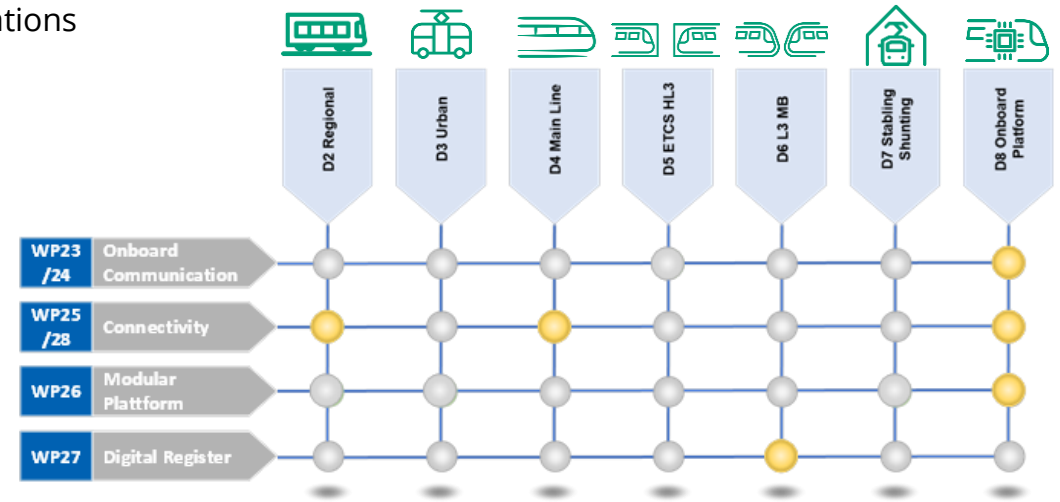
Objective: Provide the connectivity, IT (Internal Tool) and data platforms required for the automation of rail operations and increase the cost efficiency in the rail system by:

- Leveraging off-the-shelf IT solutions
- Decoupling the life cycles of railway applications and connectivity, IT and data platforms
- Allowing to aggregate multiple railway applications on common platforms



The cluster serves as a foundation for the development of additional clusters in FP2-R2DATO and demonstrators. Pivotal elements for ATO systems such as the Digital Register and FRMCS as well as technologies ensuring evolvability and adaptability such as the modular platform are developed in our cluster.

The cluster includes the following Technical Enablers (TE) and related Demonstrators :



6 Clusters
48 WPs

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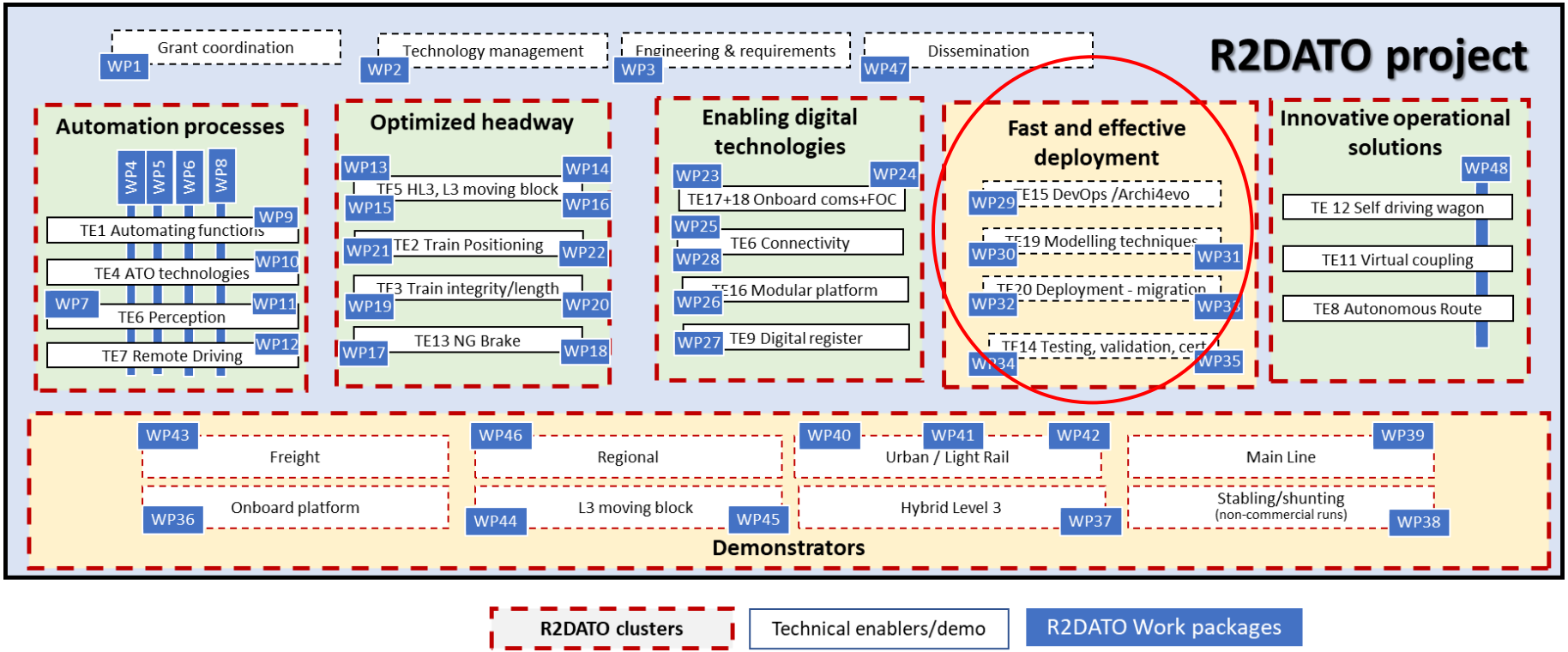


Cluster 4 : Fast & effective deployment

How is R2dato delivering impact ?

What are the challenges / painpoints we want to address ?

- Authorisation of products and modification of railway assets is still based on **human judgement** (risk and cost driver)

Main question: How can we speed up and optimize?

- **How to reduce** on site testing and detect errors as early as possible to save time and costs?
- **Long lifecycle**, adaptions (maintenance) **vs. short release** cycles (new features and fixes)
- **Lack of standard requirements** (e.g. ATO onboard) will increase risks and costs

What are the goals, objectives of that topic ?

Fast and effective deployment

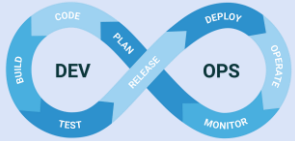
By providing generalizable frameworks, we can deploy faster, cheaper and improve quality!

- To improve operational excellence **by enhancing the evolvability** of architecture and using a DevOps strategy
- To improve quality, reduce costs and risks **by automating the authorisation** of products and modifications of railway assets
- To improve quality and reduce costs and risks **by developing and delivering a model** for ATO on board and TCMS Data Service
- Cost efficient deployment of products **by providing a common strategy, tools and process** for testing, validation and certification
- To support the sector's decision-making process **by delivering a business case (value) framework**

ATO: Automatic Train Operation
DevOps: A set of practices that combines software development (Dev) and IT- operations (Ops)
TCMS: Train Control and Monitoring System

How is R2dato delivering impact ?

What impact are we delivering ?



- Shorter lead times
- Higher quality
- Reduced costs
- Standardisation

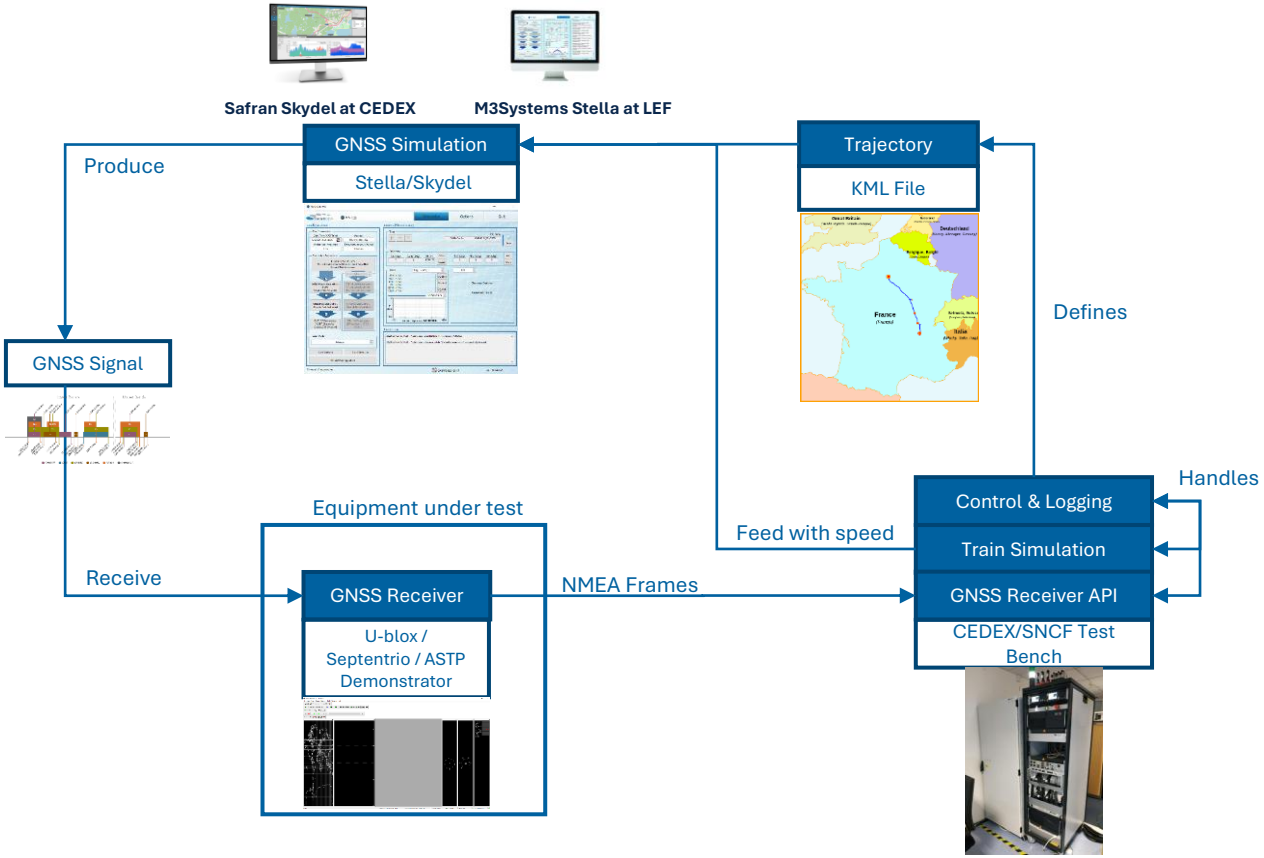
- Collaborative network of European laboratories to **validate** and **certify** new onboard systems efficiently
- Virtual prototyping from the specification to the validation **to increase speed and quality of development**
- **Better decision-making** based on CostBenefitAnalysis & value framework
- **Guidelines and concepts** for migration and deployment

How does it contribute to our KPIs ?

Provide Process KPI's as input for the demonstrators / R2DATO KPI's

- Process efficiency, e.g.:
  - Staff productivity
  - Unit costs
- Process cycle time, e.g.:
  - Total lead time of software development/releases
- Process effectiveness, e.g.:
  - Quality of test results, validations, software releases
  - Error rate
  - Customer satisfaction

Virtual Certification : GNSS Constellation Simulation in ETCS laboratories



- Development to interface ETCS test bench with a GNSS Simulator
- First evaluation of the KPI defined in WP22.4 to evaluate a demonstrator
- Comparative study between Skydel and Stella GNSS simulator
  - ✓ Skydel-Stella input/output: check if there is any drift of the position
  - ✓ Check of the consistency between the input trajectory and the estimated position on the same GNSS receiver

ASTP: Advanced Safe Train Positioning
ETCS: European Train Control System
GNSS: Global Navigation Satellite System

6 Clusters
48 WPs

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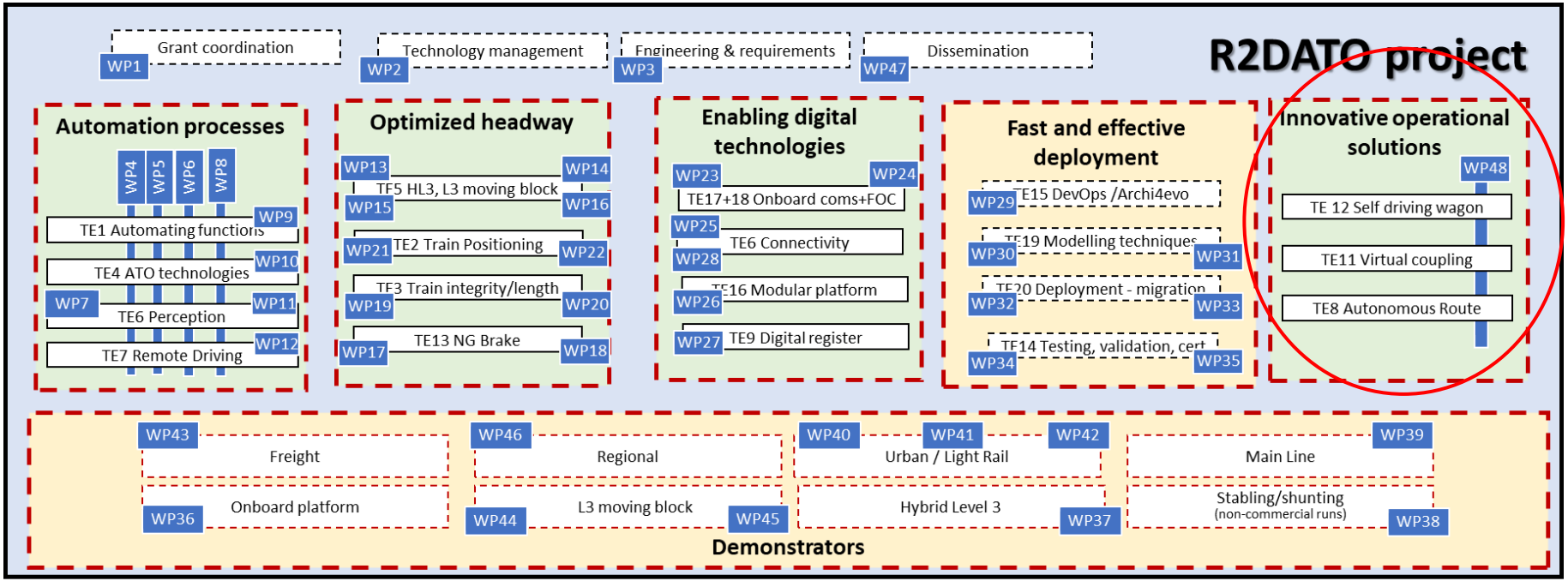


How IoS proposes solutions beyond FP2-R2DATO capabilities

Virtual Coupled Train Sets (VCTS)

Target

- Technical Enabler TE11
- Increase Flexibility and Efficiency of passenger lines – especially on frugal lines
- Enable automatic train size adaptation
- Reduce weight and disturbance from mechanical coupler
- Prepare dynamic maneuvers

Approach

- Identify or update operational use cases for VCTS (Virtually Coupled Train Set) e.g. from FP6-FutuRe or X2Rail-3
- Keep existing systems for communication and absolute positioning
- Adding systems for relative positioning and short-range / train-to-train communication system

FP2R2DATO

Control of virtual coupling operation

Short range / Train-to-Train Communications

Radio Ranging & Relative Positioning

FP6-FutuRe
Cost effective regional lines

Development of Train for frugal lines

Picture: DLR

How IoS proposes solutions beyond FP2-R2DATO capabilities

Enabling additional technologies

For virtual coupling and self-driving freight waggons additional technologies are relevant to reach the required level of performance

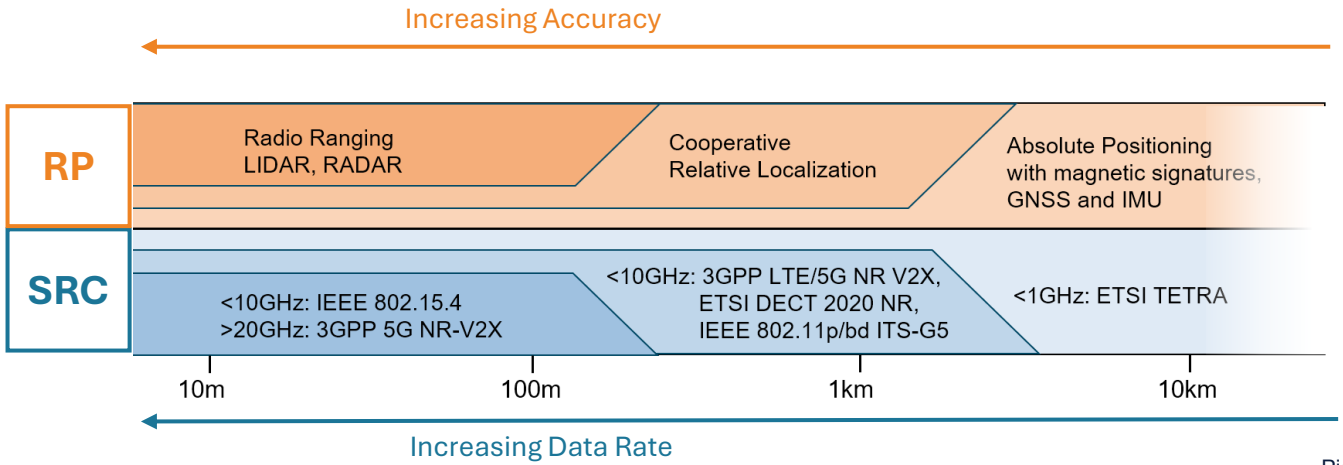
Tests planned in cooperation with the shunting and stabling demo

Short-range Communication (SRC)

- Securing low latencies
- Increasing data rate
- Ensuring redundancy with safety

Relative Positioning (RP)

- Increase (relative) precision with safety
- Increase data rate
- Increasing redundancy



Picture: DLR

6 Clusters
48 WPs

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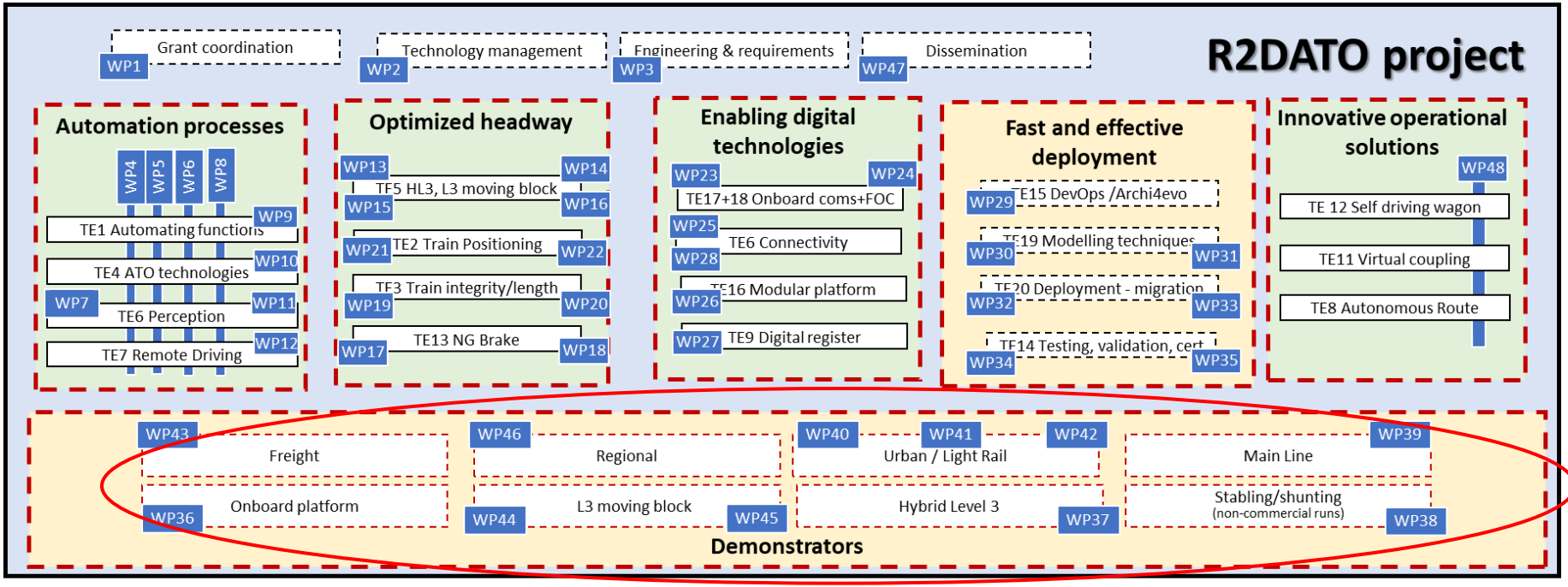
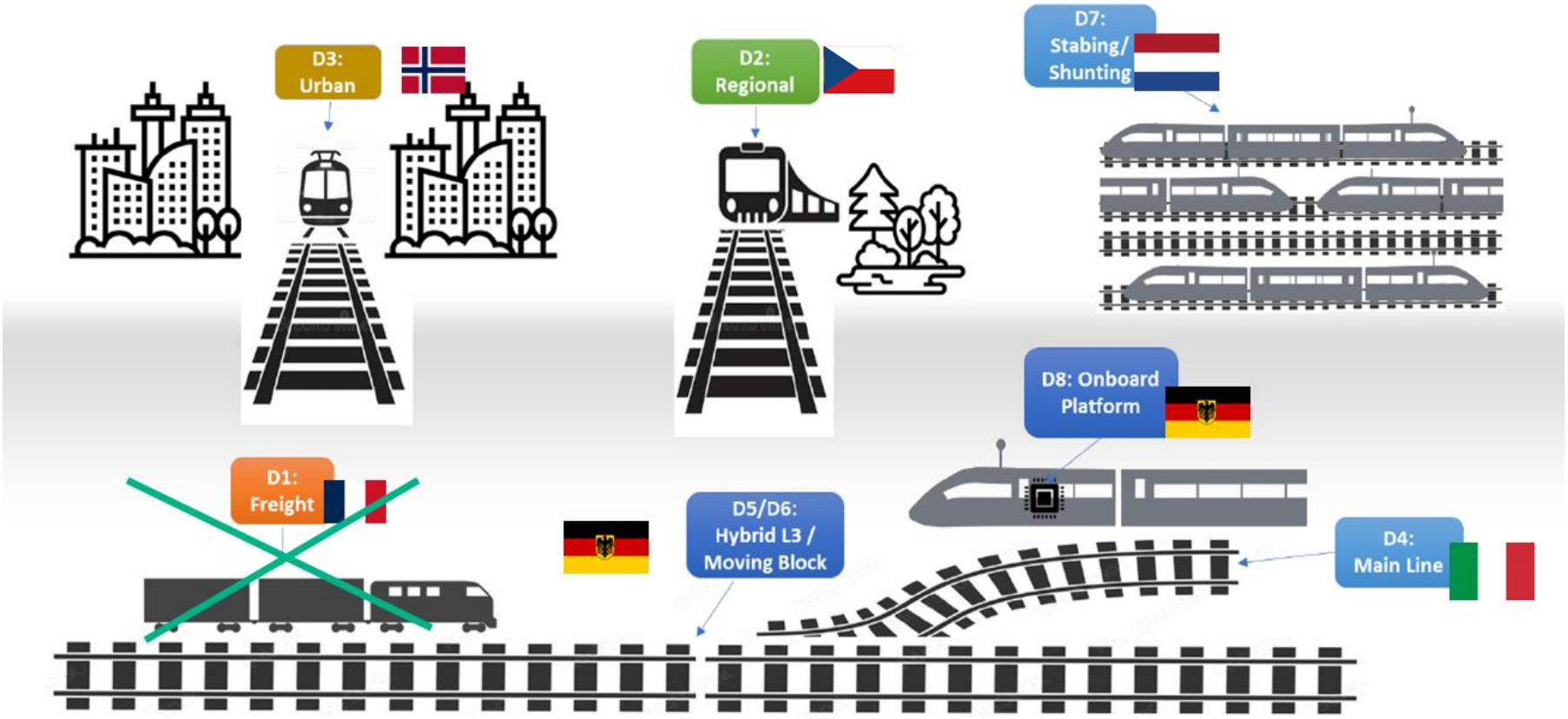


Demonstrators

7 Demos



Demonstrator D2 – regional

7 Demos

DEMO Input from

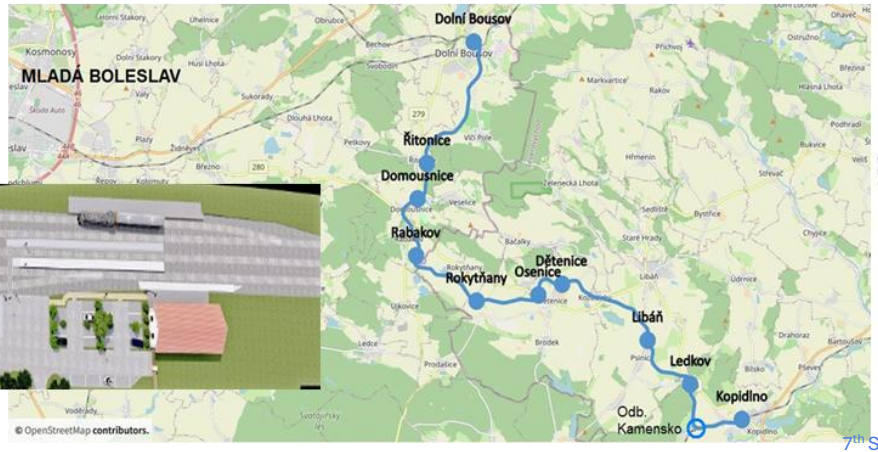
- **TE1** Automatic functions
- **TE2** ASTP
- **TE4** ATO Technologies
- **TE6** Perception
- **TE7** Remote Driving

- Main objective is to support validation and testing of technical enablers developed in R2DATO in regional line environment
- Focus is on demonstration of ATO up to GoA4 functionality in full operation with onboard and trackside components, following defined architecture, use cases and requirements (from R2DATO relevant clusters)
- Major ambition is to demonstrate interchangeability of specified components like Perception, Repository, Automatic Driving Module, Positioning, etc. provided by various suppliers

Interfaces to

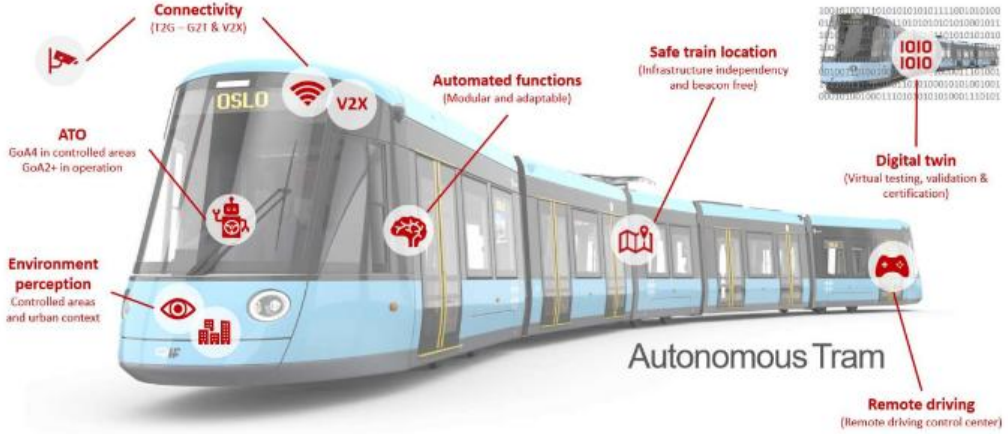
SP Specification | Architecture | STIP

FP6 Specification, Operational Procedure



D3 Urban: Tramdemo in Norway

7 Demos



- **Sporveien depot** on Holtet is **the site for testing** and demonstration activities for FP2 R2DATO scope
- **Closed area** with no public access
- **Openair depot** with possibility to simulate **diversity of use** cases and under various light and weather conditions
- **CERES – CAF operational central** for remote driving located at site with direct access and view to testing tracks

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Demonstrator D4 – mainline

7 Demos

DEMO Input from

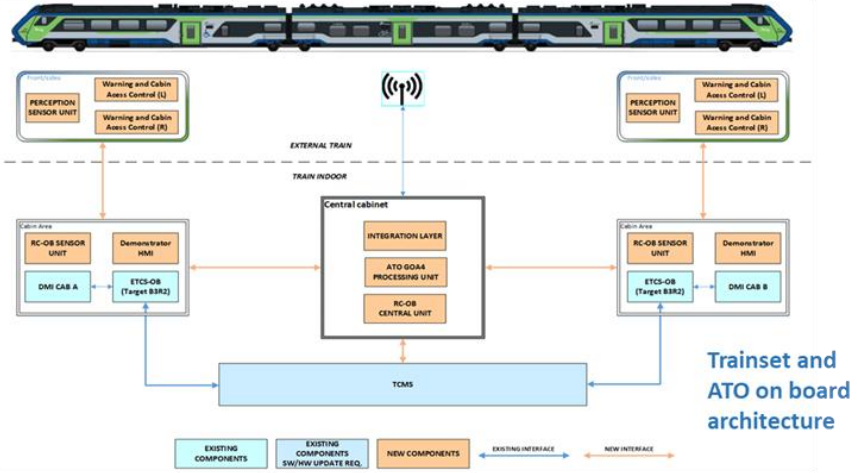
- TE1 Automatic functions
- TE4 ATO technology
- TE6 Perception
- TE7 Remote Driving

- Prepare to demonstrate the solutions DATO over ERTMS technology can bring to relieve bottlenecks in main lines in high-density networks with heterogeneous traffic
- Showing the relevant advantages deriving from the synergy between the digital automatic train operation up to GoA 4 and the CCS evolution, increasing the capacity and punctuality of railway lines

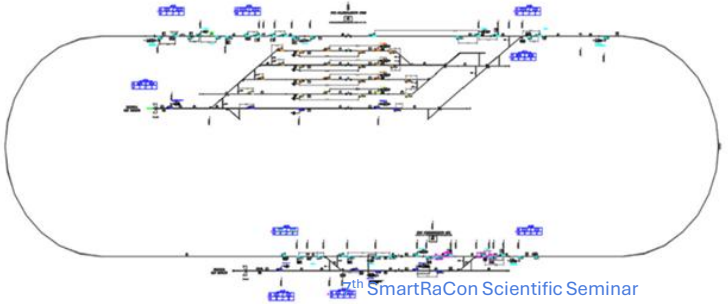
Interfaces to

SP Specification | Architecture | STIP

FP1 | **FP2/FP6**



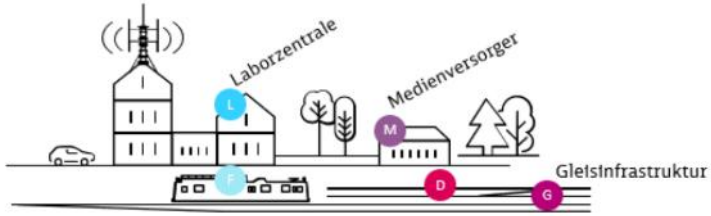
Trainset and ATO on board architecture



D5/6 HTD / Moving Block

7 Demos

- L Laborzentrale
- D Digitale Leit- und Sicherungstechnik (DLST)
- G Gleisinfrastruktur
- F Laborfahrzeug Digitale Bahntechnologien (ATO)
- M Medienversorger
- 5G 5G-Funkinfrastruktur



Schwarzenberg

Scheibenberg
Standort des Erprobungsbahnhofs mit Laborzentrale und Laborfahrzeug

Schlettau

Annaberg-Buchholz
Erstes digitales Stellwerk Deutschlands

Markersbach

- Digitales Testfeld Bahn (24 km lang)
- 5G Teststrecke (10 km lang)

Demonstrator D7 – Stabeling / shunting

7 Demos

- TE7 Remote Driving
- TE4 ATO Technologies
- TE6 Perception
- TE13 NG Brake

Demo #1:
NS SNG Train (CAF Civity)
Testing of 38.2, 38.3, 38.4, 38.6, & 38.8
(ATO & RTO in shunting operations)

Status:
Retrofit: ☑
Derogation: March 2025 ☑
Demonstration: May - June 2025 ☑

Demo #2:
NS SNG Train (CAF Civity)
NG Brakes (Knorr-Bremse)
Testing of 38.5

Status:
current scope and timeline being planned;
demonstration will take place Feb-Apr 2026

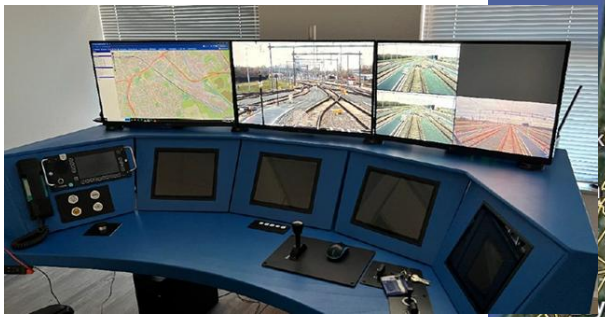
Key Interactions

- WP10: Prototype development of Automated Driving (ATO Technologies) > Task 10.1
- WP11: Prototype development of perception system. > Task 11.2
- WP17: Design conception of integration of NG-Brakes system

Demonstrator D7 – Stabeling / shunting

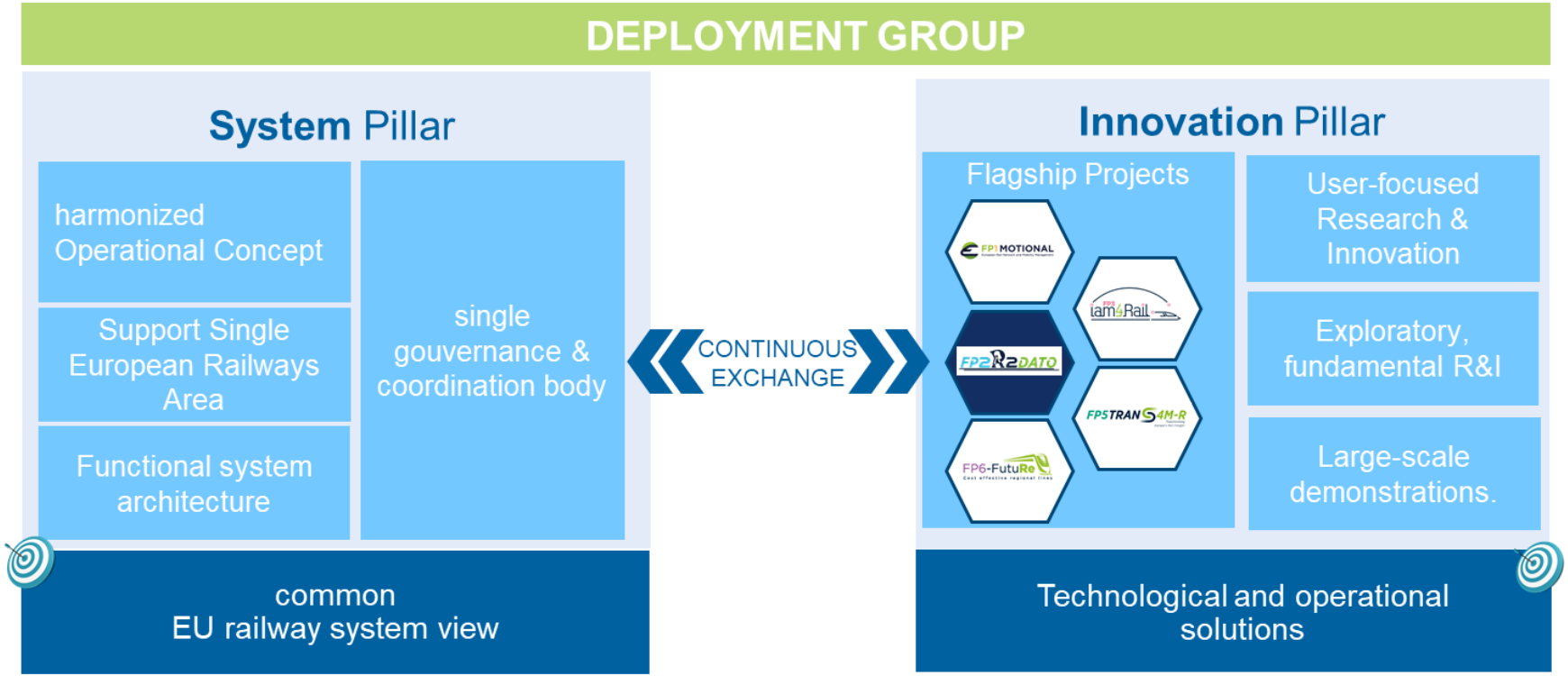
7 Demos

The yard and track to Groningen Central Station



Remote & automated controlled train

Ecosystem Interaction



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Ecosystem Framework

Innovation & Development Activities

Europe Rail Joint Undertaking

System Pillar [SP]

harmonised architecture of European Railway system

Harmonised operational concept

Development of specifications based on top-down system engineering approach

Innovation Pillar [IP]

Development of innovative technical solutions

Demonstrator's to show feasibility

Standardisation, Regulation & Deployment

Standardisation & TSI Input Plan [STIP]

Collection of the topics from SP and IP relevant for harmonisation

Alignment with the EC request for TSI revision

Allocation of harmonisation channel & time planning to topics

European Standards

- CEN
- CELENEC
- ETSI

TSIs

Deployment

- Development of products
- Investment plans
- Broad deployment
- Migration targets

IMs, RUs, suppliers

align

EC request for TSI revision & standardisation [EC, ERA]

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Questions?

Website:

https://rail-research.europa.eu/pages/fp2-r2dato/objectives