CSFM Mini-Conference 2024 on Technological Perspectives and Scientific Challenges of Automatic Train Operation

Brown Field ATO: Are Cost-Efficiency and Social Sciences Key?

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Europe's Rail

Co-funded by
the European Union

ATO @ EU-Rail

Short recap

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EU-Rail Mission

Rail Research and Innovation to make Rail the everyday mobility

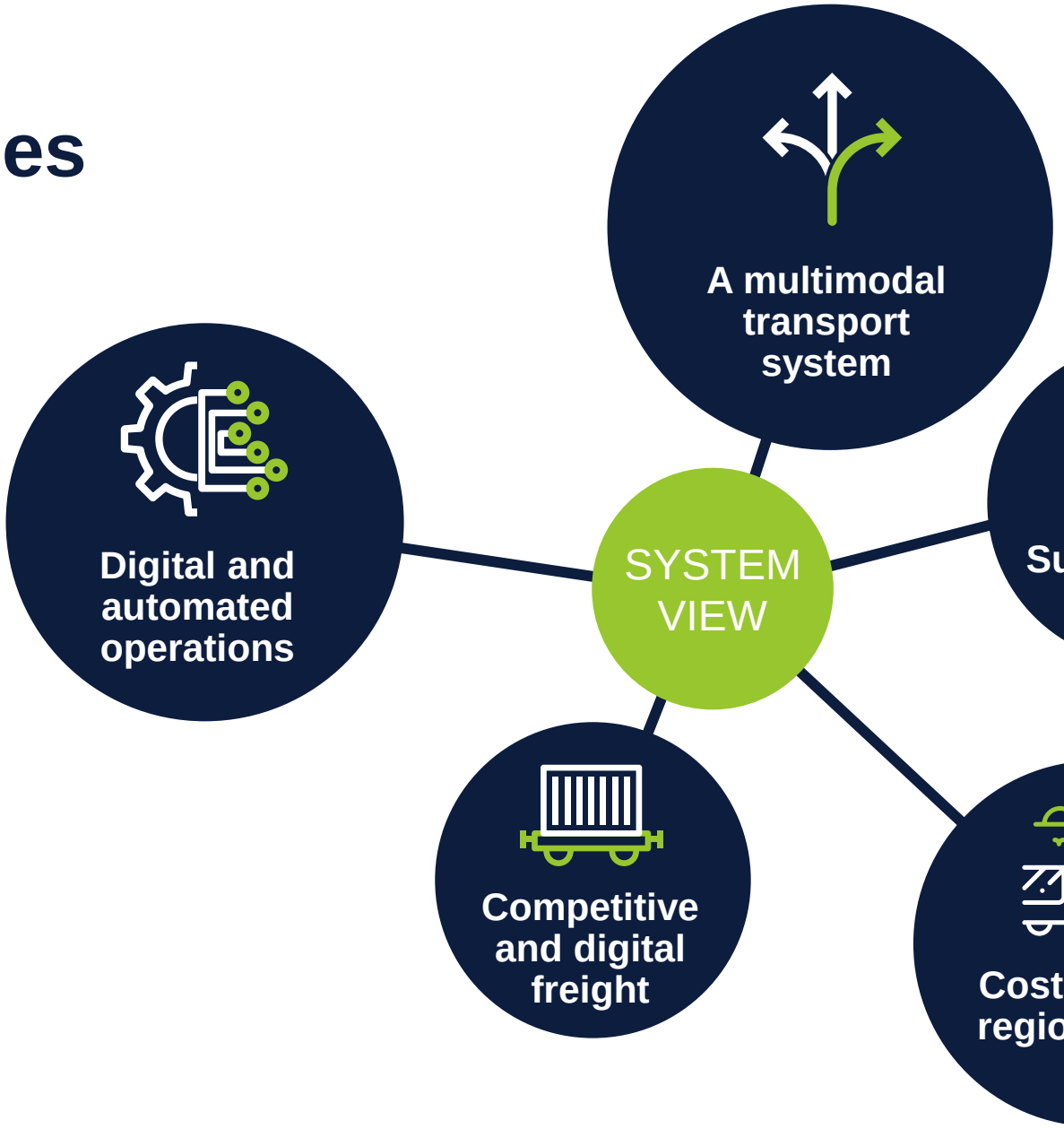
European partnership on rail research and innovation.

Autonomous body established under the Horizon Europe programme (2020-2027)

Research and Innovation for transformation in rail systems

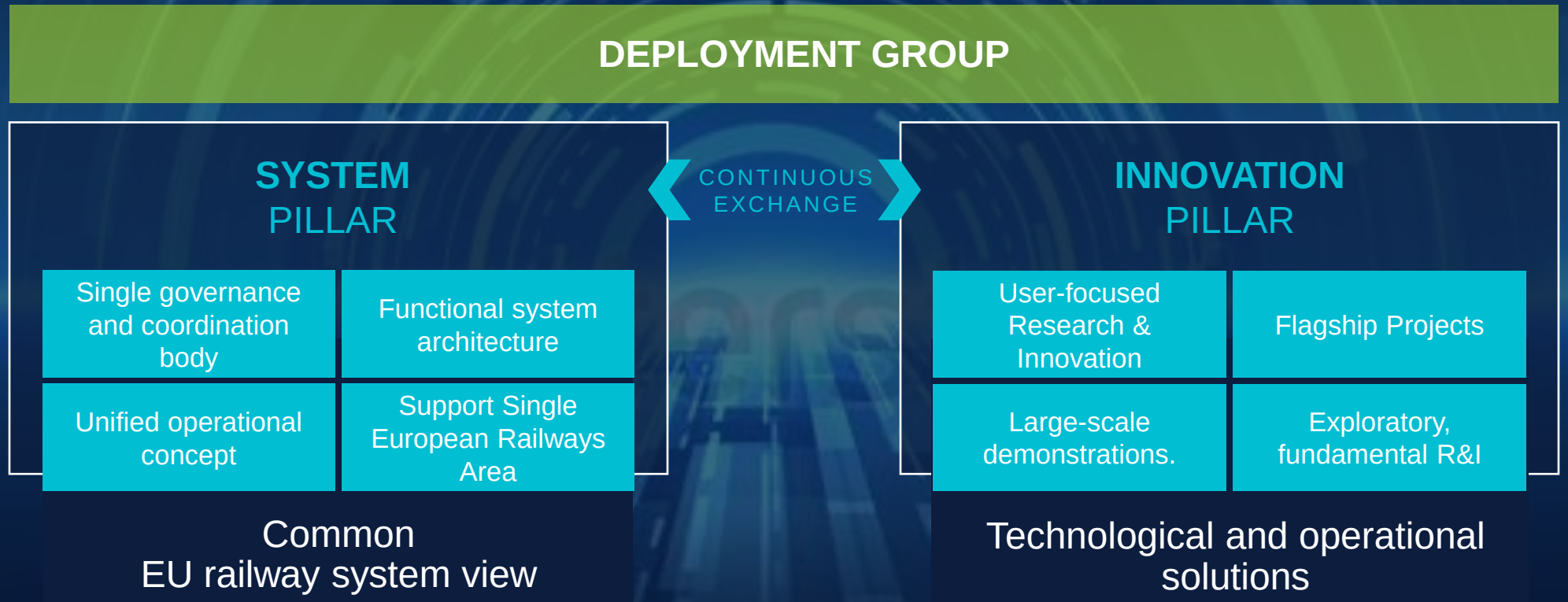
Council Regulation (EU) 2021/20853 of 19 November 2021 (Single Basic Act), successor of the Shift2Rail Joint Undertaking (S2R)

Priorities

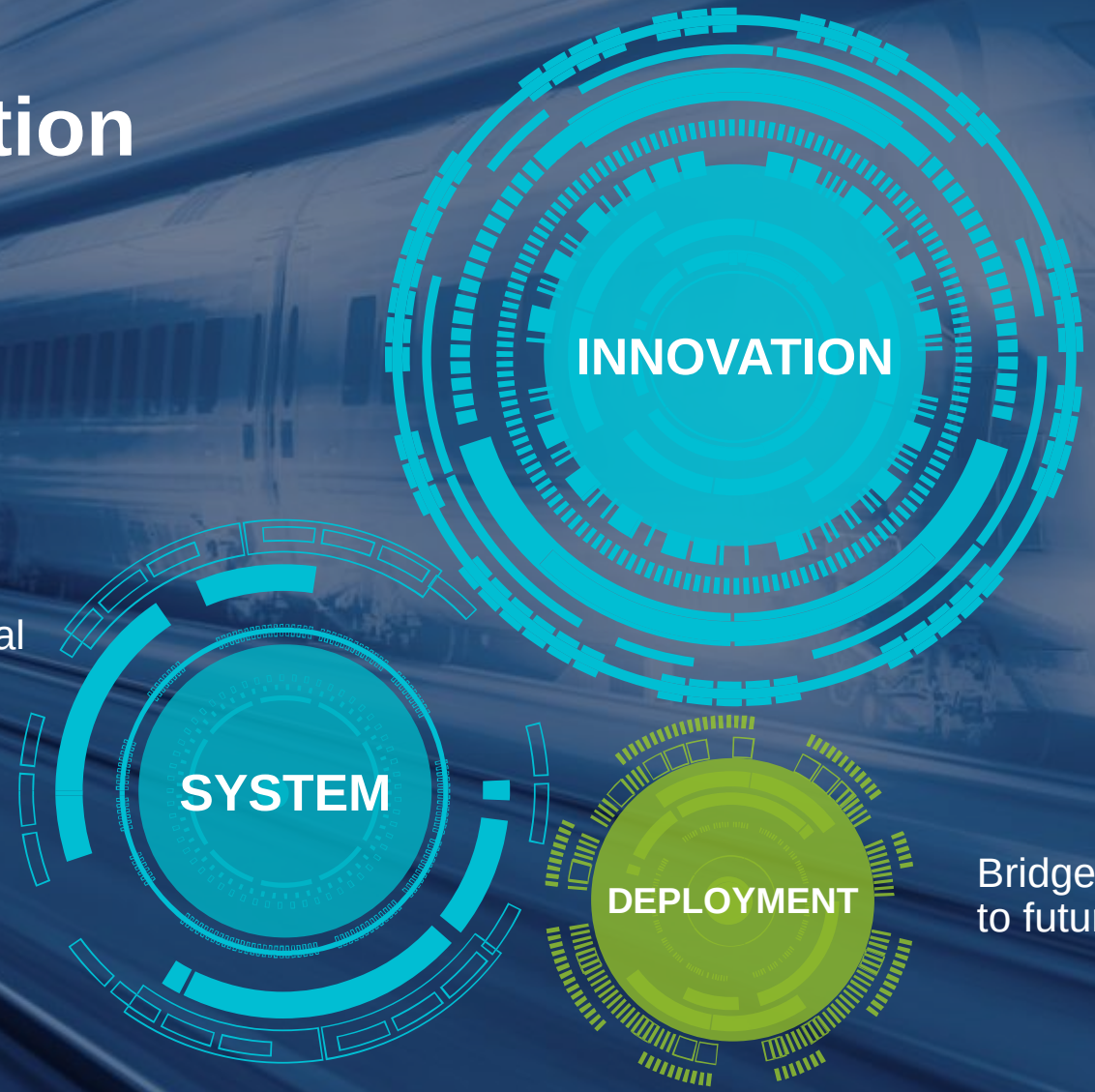

A multimodal transport system
Digital and automated operations
SYSTEM VIEW
Sustainability
Competitive and digital freight
Cost-efficient regional lines


AI GENERATED

Single R&I Programme based on a system view



Implementation



- Ensure that the functional system architecture
- Flexibility in implementation
- Ownership of results

Members contribution up to
€576 million

Call 2022 (50% of R&I)
Call 2025/2026 (30%)
Call 2027: activities until 2031

Launching calls for proposal/tenders to explore new areas of rail R&I

Bridge research and innovation to future coordinated deployment

Innovation Pillar

GOAL

Cover all necessary stages of the innovation cycle, ranging from low to high TRLs and targeting large-scale integrated demonstrations.

Flagship Areas leading to Flagship Projects

- Network Management planning and control & mobility management in **a multimodal environment**
- Digital and automated up to **autonomous train operations**
- Intelligent and integrated **asset management**
- **Sustainable and green rail system**
- Sustainable **competitive digital green rail freight** services
- Regional rail services / innovative rail services to **revitalise capillary lines**
- Innovation for new approaches on **guided transport modes**

Exploratory research activities

Technologies and innovations from other sectors
Game changing methodologies
Disruption of innovation cycle

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EU-RAIL PROGRAMME

Innovation Pillar

END 2023

6 Flagship Projects

8

Explorative and disruptive research projects

7

Topics were launched

including a **first** joint call with SESAR JU

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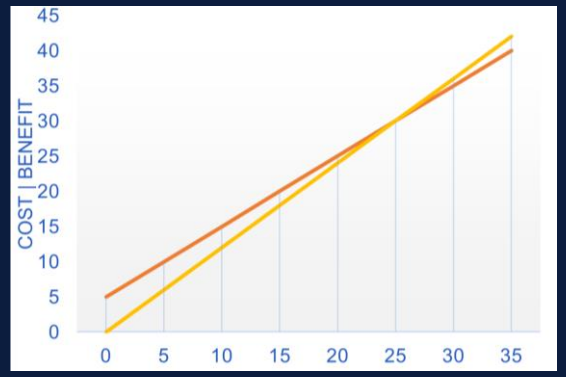
Brown field ATO

A quick overview

Banal truths

Engineers look for technological perspectives - automation is a *socio-economic optimisation problem*



The technical solution requires resources and induces cost

→ commercial break even

The output of automation may feature less serial deviation, better precision, faster processing times etc.

→ 'quality break even'

We do not automate skiing or playing tennis

→ 'social break even' (we must let go doing it ourselves)

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Banal truths

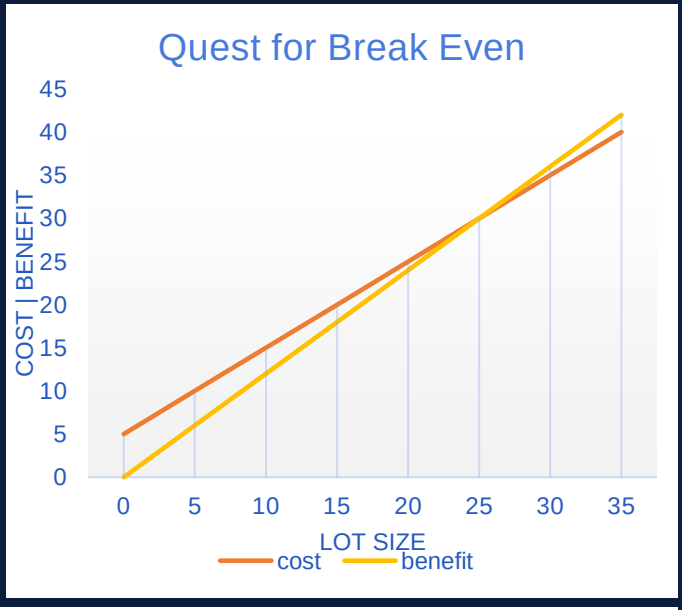
Automation is action centered; NOT result centered

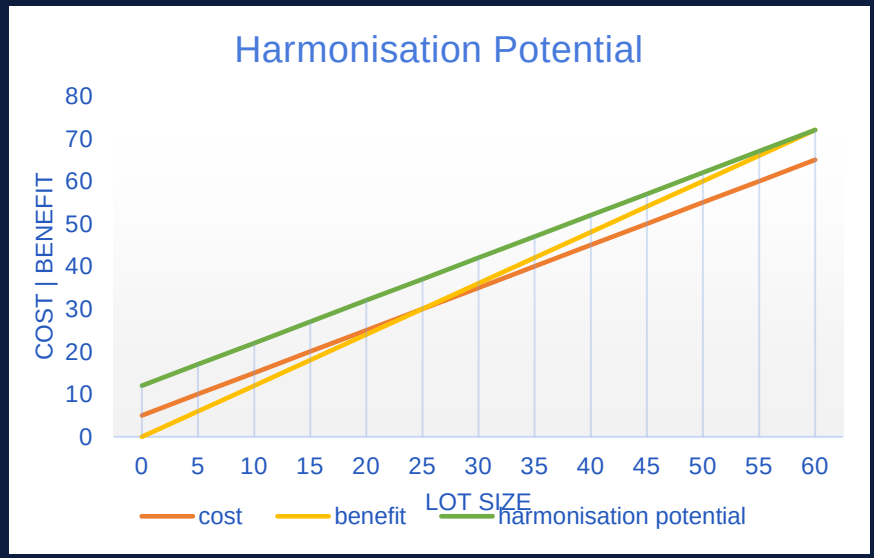
Which actions

- … do I want to automate?
- … have a benefit when automated, in quality or cost?
- … are frequent enough to exploit the benefit and break even commercially?

Answers depend on subjective perceptions and acceptance, operational processes, re-use/lot sizes for deployed solutions.

The better operations are harmonised, the easier to break even.





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Banal truths

Harmonisation benefits

Therefore in 1909 I announced one morning, without any previous warning, that in the future we were going to build only one model, that that model was going to be Model "T", that the chassis would be exactly the same for all cars and I remarked:

"Any customer can have a car painted any color that he wants so long as it is black".

I cannot say that any one agreed with me. The selling people could not of course see the advantages that a single model would bring about in production.

Henry Ford, 1922

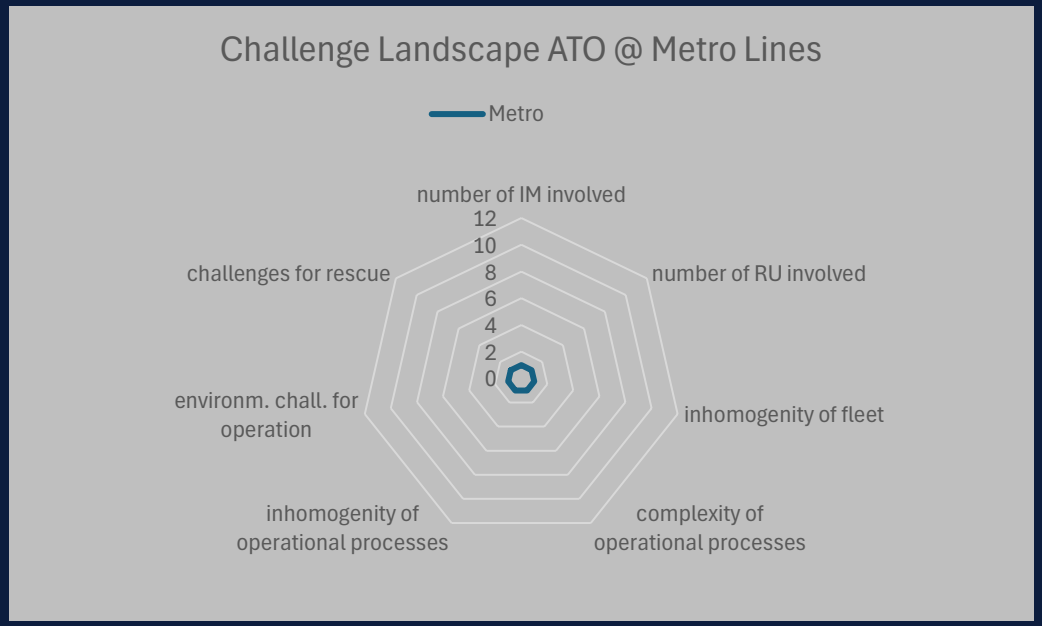
Source: McClure's Magazine, Volume 54, S.S. McClure Company, 1922 (as provided by Google search)

Why so little progress?

Where ATO is well established

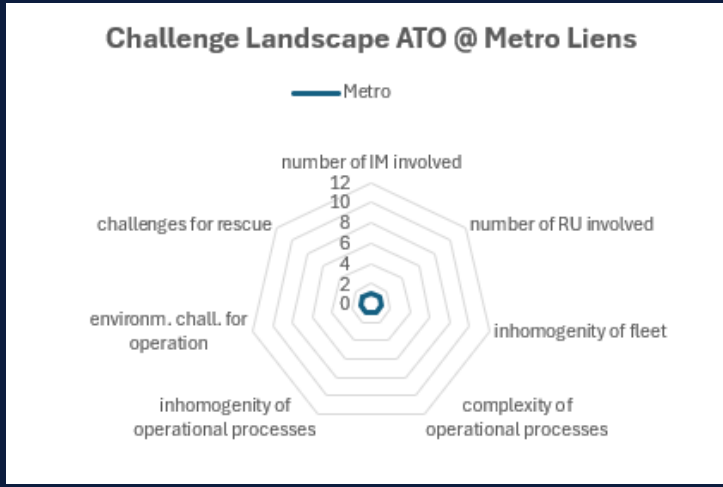
Metro lines for 50 years now driverless

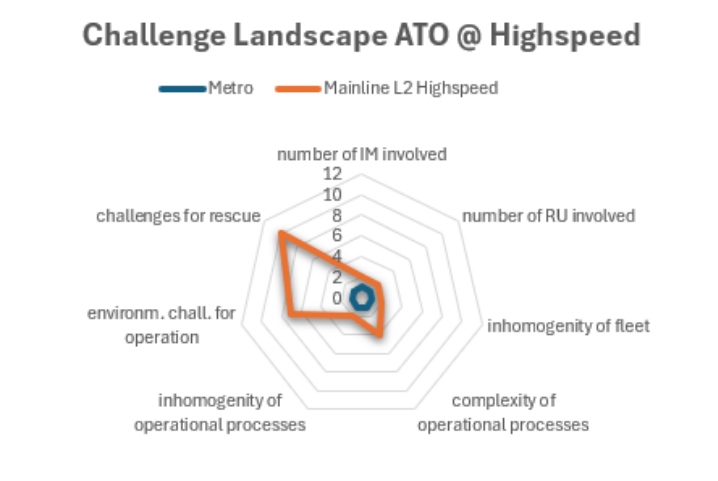
- easily understandable what to automate
- customer accepted incident resolution
- cost efficiency in roll out and retrofitting
- single provider big bang approach is possible
- … ➔ easy challenge landscape

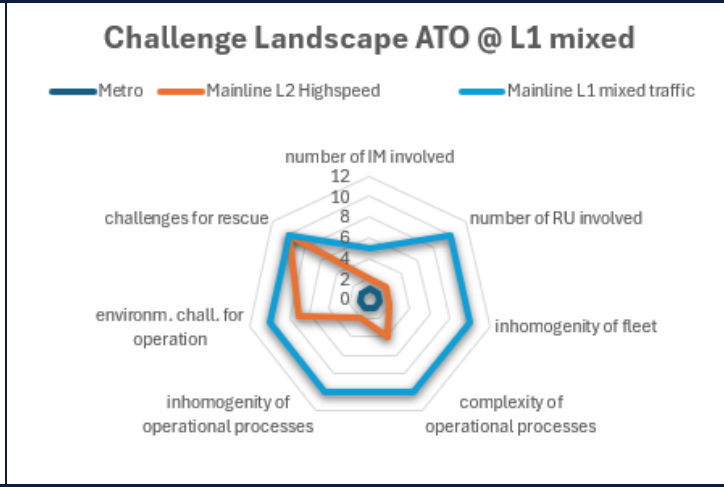


Why so little progress?

Operational challenges cause a wide variation of scenarios to cover







Consequences from the challenge landscape

Catalogue of operational scenarios and non-standard operations is very diverse:

If every project gets its tailor-made solution, no 2 projects will be using the same equipment; all lot sizes for production will be below the industrial threshold (‘arts & craft’). No re-use, no economy of scale, etc.

Increasing the lot size for developments:

- Harmonising operation incl. harmonising the catalogues of non-standard operations
- Harmonising customer accepted incident resolution
- Harmonising decision on which part of operations to automate by ATO

➔ leverages resources and cuts cost

“As a result, the variability of requirements baselines will grow over-proportionally with the introduction of additional features, if operational requirements are not harmonised. There is no chance for suppliers to compensate for this effect.”

“To pursue the standardisation of technical requirements without the harmonisation of operation, will lead into an economical dead-end. “

From: UNIFE position paper “The impact of operational requirements on the future of the European railway sector”, April 2024

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Now what?

EU-Rail approach in a nutshell

- Identify what to automate
- Harmonise operations
  (particularly between IM & RU)
- Understand the ‚social break even'
  (general acceptance by involved
  stakeholders;
  acceptance of degraded modes /
  exceptional situations handling)
- Improve installation, roll out and retrofit cost
  (and restrict to cases which break even)

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What to automate?

Identification of actions to automate

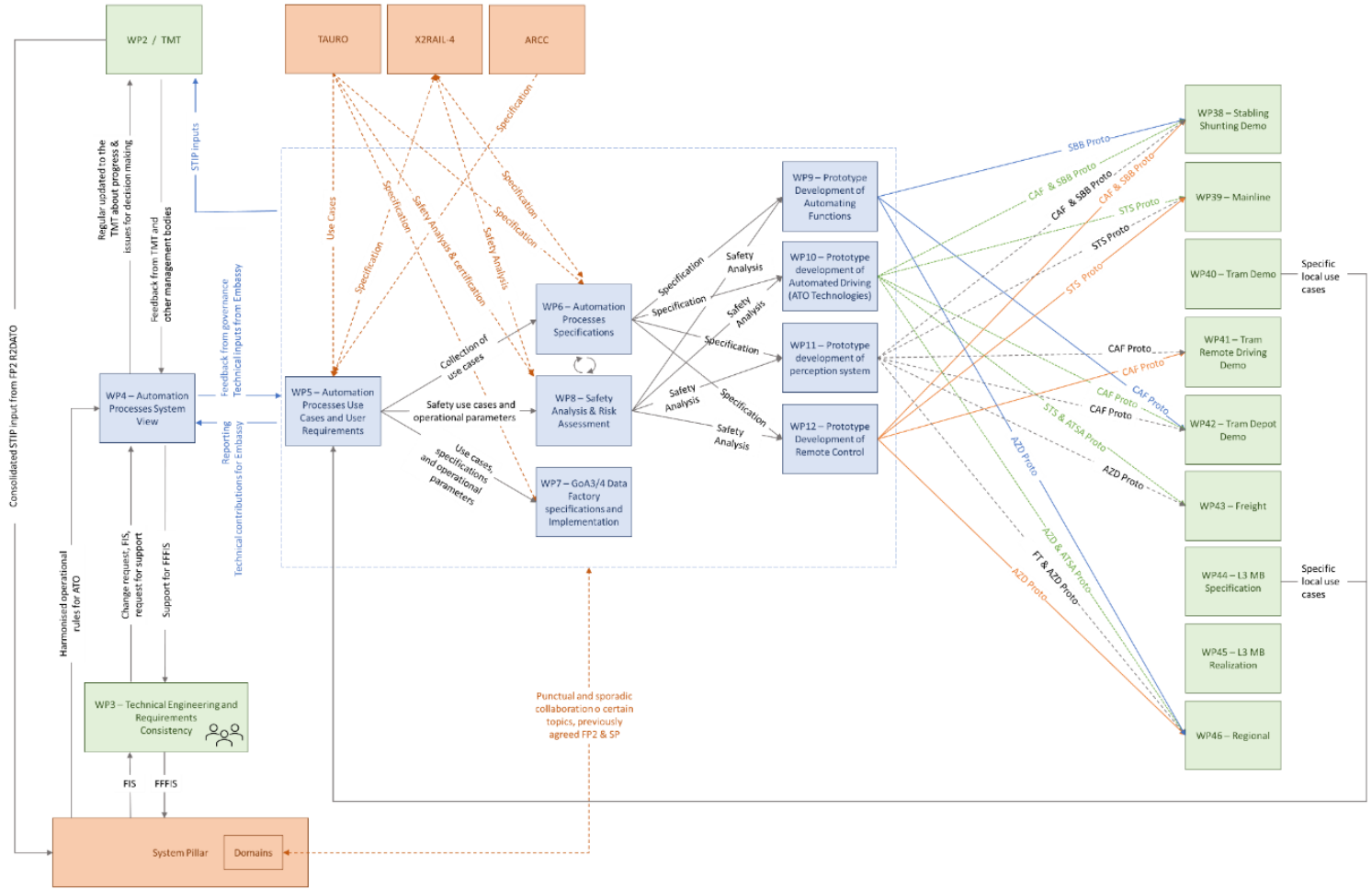
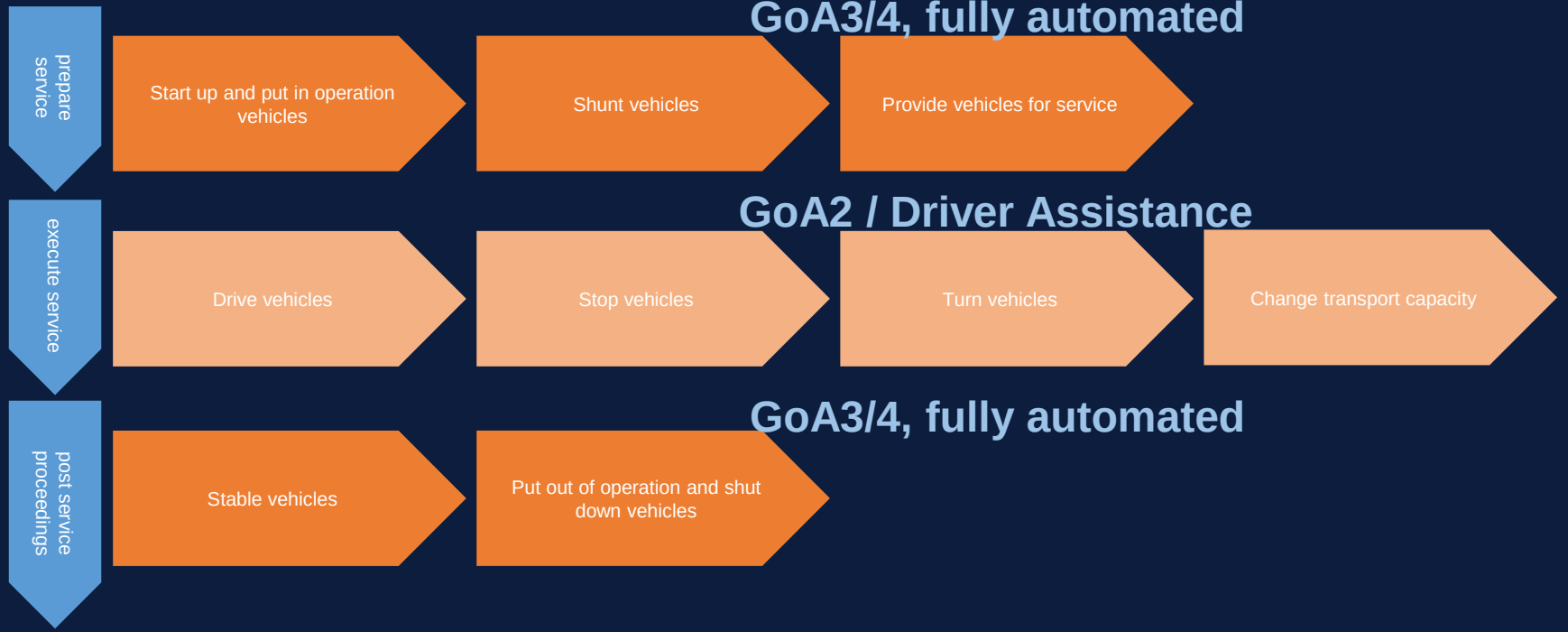


Figure 2: Interfaces

Current analysis for Switzerland from Swiss sector programme ATO

Structure of actions to automate



Source: ATO Branchenprogramm Schweiz, https://www.voev.ch/de/System-Bahn-RTE/ATO-Branchenprogramm

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What to automate?

Huge catalogue of use cases

>1100 identified

This cannot be handled hoping for good results

➔ Focus on 74 use cases and 29 operational scenarios

➔ Degraded modes, fast and simplified deployment are among the highest priority topics

Due to time constraints for the work package and delays in the delivery of formal inputs from other projects, the task 5.1 partners focused on simultaneously identifying the full set of potentially relevant operational scenarios and use cases based on the 'day in the life of' analysis. This analysis led to a total of over 1100 identified use cases and scenarios, which either were (or would soon become) available, or could potentially be developed within task 5.1 or other WP5 tasks.

From this relatively comprehensive identification, the team distilled the set of use cases and scenarios that would need development within the scope of task 5.1. This was done through a prioritization process, with input collected from the R2DATO demonstrator work packages and the group of railway undertakings on the basis of the objectives, innovative solutions, demonstrator context and impacts as defined in the Grant Agreement. These priorities were then matched with the scope of each identified use case, after which a relative ordering was made and matched with the available development capacity. To come to the final set of use cases for development, a final cut and sanity check was performed to ensure all use cases were aligned in level of detail and scope with the task 5.1 description of work.

To ensure that all use cases provided a similar result in terms of quality, considerable effort was spent during the development phase to align all development and review partners on topics such as templates, terminology and operational actors. Multiple rounds of informal and formal reviews, as well as workshops were organized, to ensure that all task partners were aligned on the final results of the development phase.

Resulting from this development phase, are a total of 74 use cases and 29 operational scenarios adding to the state of the art as input for the development of Automation Functions technology. These scenarios and corresponding use cases are described on basis of a 'day in the life of a train', resulting in a comprehensive set of use cases. The developed use cases need to be seen as additions to the already identified state of the art use cases.

Resulting from these workshops, it became clear that the highest priority should be placed on use cases for:

- Remote control
- Shunting
- Degraded modes
- High density mainlines
- On-board
- Increasing capacity
- Fast and simplified deployment

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Harmonise operations

Struggle for alignment

20 partners contributing

Alignment of operational procedures within 12 months not possible

Lead definition of operational procedures with documented acceptable variants

Result: good set of use cases reflecting actual operational procedures

Recommendations: Future projects should work on full alignment between all involved RUs on standardised operational procedures

Standardization of operational processes

While the participants would have preferred to deliver a completely standardized set of operational procedures, realistically such an alignment across all the 20 partners involved in WP5 would take years rather than the 12 months available to the team. Instead, the approach was therefore taken to have one partner lead the drafting of each use case, with an additional partner (sometimes two or more) to review a use case. If alternative operational procedures were identified by peer-reviewers, these could be added as a variant of the use case within the same document. Across all use cases, the definitions of the operational actors have been aligned as is explained in chapter 2.6.3 Definition of Operational actors.

In this way, it was ensured that good set of quality use cases would be produced, reflecting actual operational procedures, as a basis for operational demonstrations of the Automation Processes TE prototypes to be performed within R2DATO. Meanwhile avoiding pitfalls of endless discussions on standardizing the operational procedures.

Recommendations

In future projects it is therefore the task to take the lessons learned from the R2DATO demonstrations based on this generation of prototypes and the drafted operational use cases. Future projects should work on full alignment between all involved RUs on standardized operational procedures, in order to facilitate an interoperable design of the eventually matured TEs.

Harmonising customer accepted incident resolution

List of Non-Regular Situations (NRS) contributes majority of use cases, some examples:

- Handle brake malfunction – hot wheel
- Apply temporary speed restrictions for high winds
- Handle stop train unit due to security incidents on-board
- Handle overcrowded train unit
- Resolving detected open doors on moving passenger train (GoA3)
- Handle fire accident on passenger train

3.1.17 Overcrowded train unit

The use case developed for this scenario describes the situation where overcrowding is detected within a train set. It specifies the measures that need to be taken to ensure safe train operation when the number of passengers on a train exceeds capacity.

More hazardous, panic situations relating to overcrowding are included in chapter 3.1.18.

Overcrowding on the platform is not included in this chapter and can be found described in chapter 3.1.23.

ID	Use Case Name	Summary
UC5.1-049	Handle overcrowded train unit	Legal Overcrowding: OAS must inform trackside of a possible impact on dwell time. Supervise the adapted dwell times of the Journey Profile. Illegal Overcrowding: Passengers are requested to leave the train until the train (and each vehicle) has an occupation smaller than maximum occupation. If not enough passengers leave the train, the police officer(s) is/are called to clear the train (i.e. reduce the number of people inside). If the police officer(s) did not succeed, the train is cancelled.

cost efficiency in roll out and retrofitting

Other industries' paradigms:

- Lower the products' entry thresholds for the customer
- Install and set up quickly and easily
- Control the product life cycle
- Make replacing a product by a newer one easy

Us:

- among the ATO showstoppers, cost efficiency in roll out and retrofitting is the best ignored R&D target

"Railways and Suppliers have also agreed to manage the business objectives through cooperation and not in isolation, (i.e. increased cost efficiency and quicker rollout of solutions with increased performance), and shall be achieved in a combined way."

From: UNIFE position paper "The impact of operational requirements on the future of the European railway sector", April 2024

for discussion:

Take aways

- We must learn to look for the commercial potential of ATO from an operational procedures perspective, not from a ‘vision’
- We must learn to design ATO solutions for cost effectiveness, not for technical achievement
- We must learn that commercial viability of ATO comes from economy of scales, and that operational harmonisation is the lever
- We must learn to design ATO for the user experience rather than for the engineering experience
- cost efficiency in roll out and retrofitting is the best ignored R&D target
- customer accepted incident resolution is a worth while research topic
- identifying the commercially relevant operations for automation, and harmonising the related operational procedures are presumably the most powerful enablers for ATO, while both is not backed by academic research