Europe's Rail

FP5TRANS4M-R

Transforming
Europe's Rail Freight

Preliminary concepts and specifications for a self-propelled wagon

David Krüger, Mathilde Laporte, Jonan Morales, Iñigo Adin, Björn Pålsson, Behzad Kordnejad, Ingrid Nordmark

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DLR Deutsches Zentrum für Luft- und Raumfahrt

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KTH VETENSKAP OCH KONST

AVANCEZ 1829 CHALMERS UNIVERSITY OF TECHNOLOGY

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Agenda

1. Introduction
2. MoSCoW analysis
3. Traction system requirements
4. Further considerations
5. Conclusion and further work

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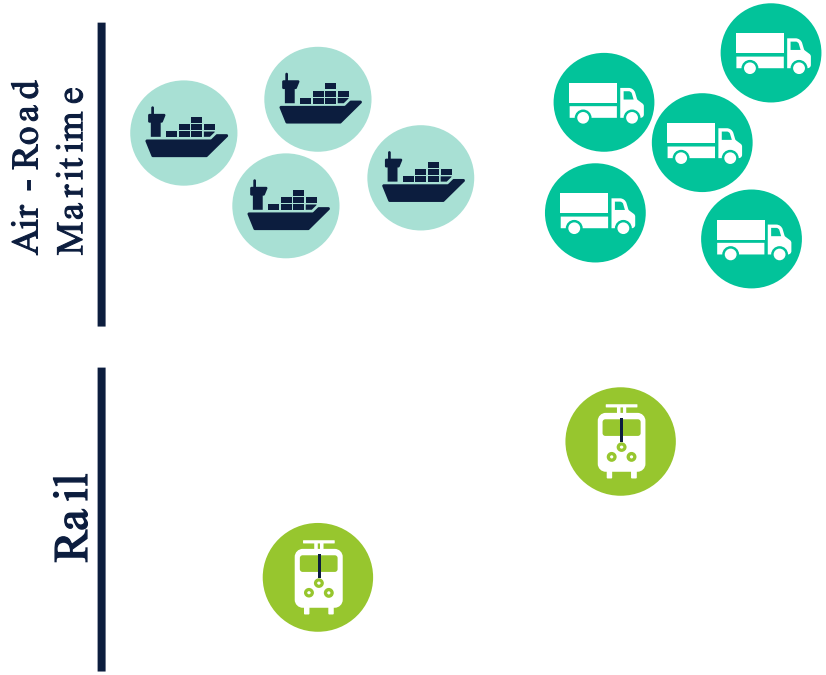
Introduction

Current challenges and main goals of the project

Our goal: Increase the attractiveness of the rail freight transport



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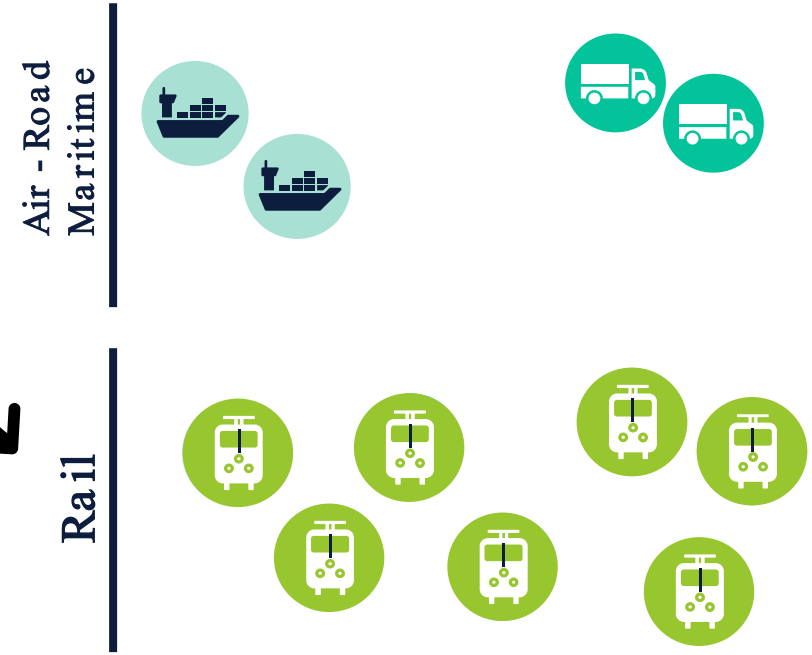
Our goal: Increase the attractiveness of the rail freight transport

- **Climate neutrality**
- **Greater flexibility** of the shunting process at the marshalling yards
- A **faster responsiveness** in the rail freight sector
- **Increase digitalization** and **automation** of the transportation chain
- **Reduce the costs**

Saving around **105 grams of CO_2** per tonne-kilometre!



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- Labour-intensive process of preparing wagons
- Conducting manual checks before the train departs
- Dispatching and staffing of locomotives
- Only one group of wagons can be moved at a time

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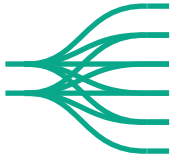
- **Greater flexibility** of the shunting process at the marshalling yards 
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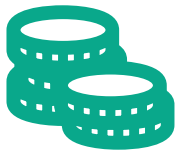
- **Reduce the costs** 

One of the best solution

Self-Propelled Wagon

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MoSCoW analysis

Method and definition

M

Must Have
Initiatives that must not lack in your product

S

Should Have
Essential initiatives but not vital in your product

C

Could Have
Initiatives that are nice to have in your product

W

Won't Have
Initiatives that are not the priorities in your product

Defined sub-systems for the analysis:

- Wagon construction & other sub-systems
- Data management & control system
- Traction system
- Braking System
- Battery system

MoSCoW analysis

Results and interpretation

Wagon construction & other sub-systems

- M: Be able to work when the wagon is uncoupled or coupled into a consist
- S: **Energy supply** to goods being transported
  Ability to **retrofit existing wagons**
  Autonomous driving (GoA3)
- C: **Obstacle** detection
  Loading/unloading capabilities
  Enable transportation of **ILU's**

Battery system

- M: Regenerative braking
- S: Be capable of **heating**
- C: Be capable of **cooling**

Traction system

- M: **Boosting** capability at high speed
  Supported distributed Power (DPS)
- S: Ability to climb at least **1,25% grade**
- C: **Power reserves** to haul other wagons

Data management & control system

- M: **Support train** run functions and train operation modes (TOM)
- S: Tablet based **read out/interface/HMI**
- C: **Smart** connectivity

Braking System

- M: **Regenerative braking** from high speed (120 km/h)

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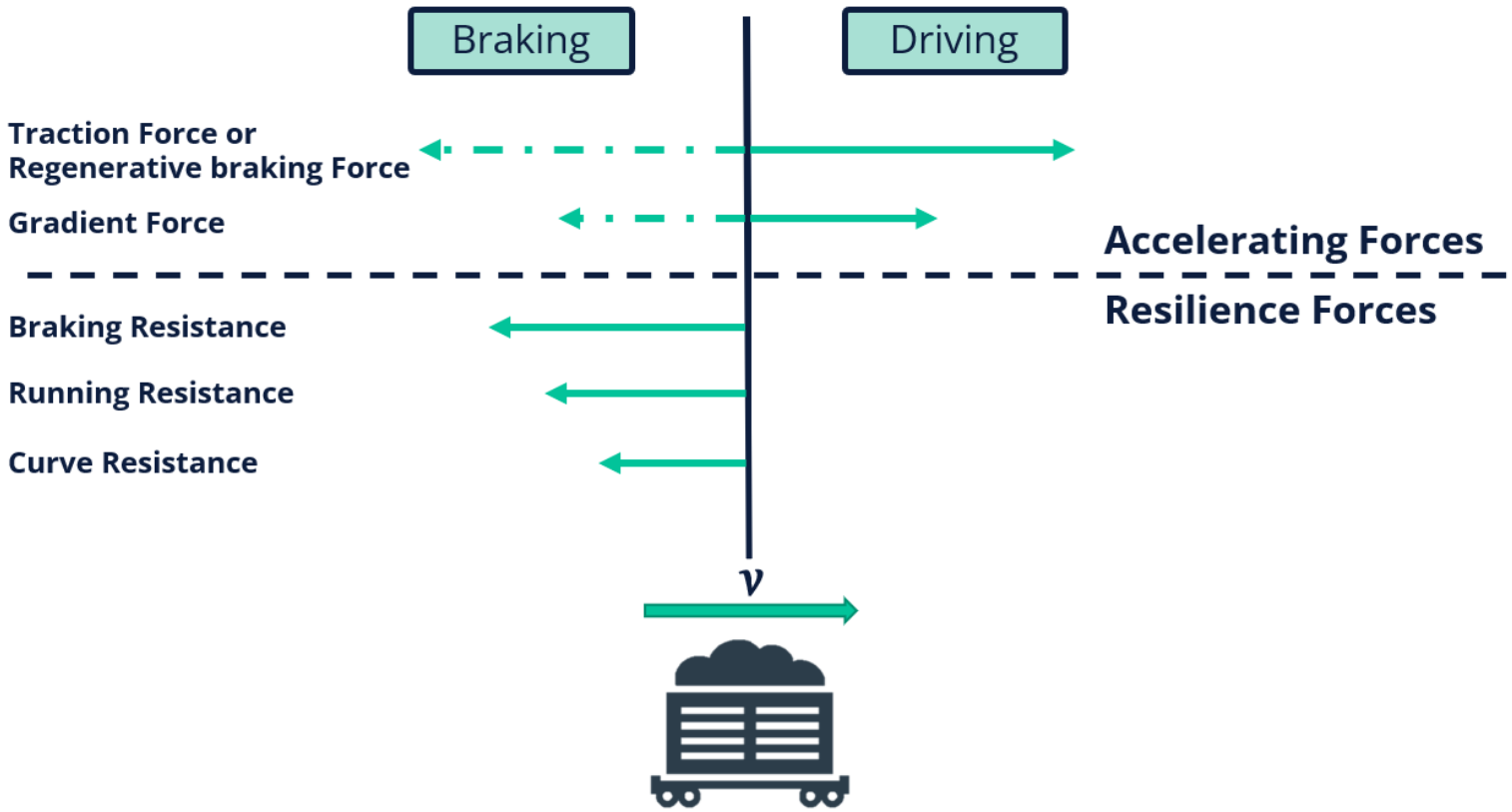
Traction system requirements

Fundamental effects and forces

Maximization of attractiveness through consistent minimization of costs by concentration on the core applications of shunting, boosting and regenerating

OR

Maximization of the range of potential applicability of the product in last mile applications through longer range and greater tractive effort



Travel longer distances in more challenging conditions

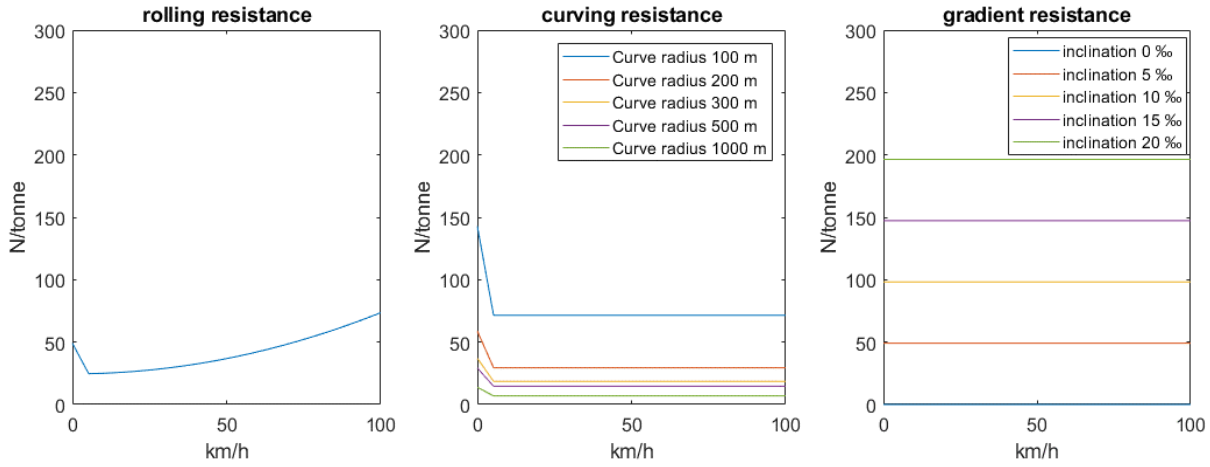
OR

Shunting, boosting and regenerating

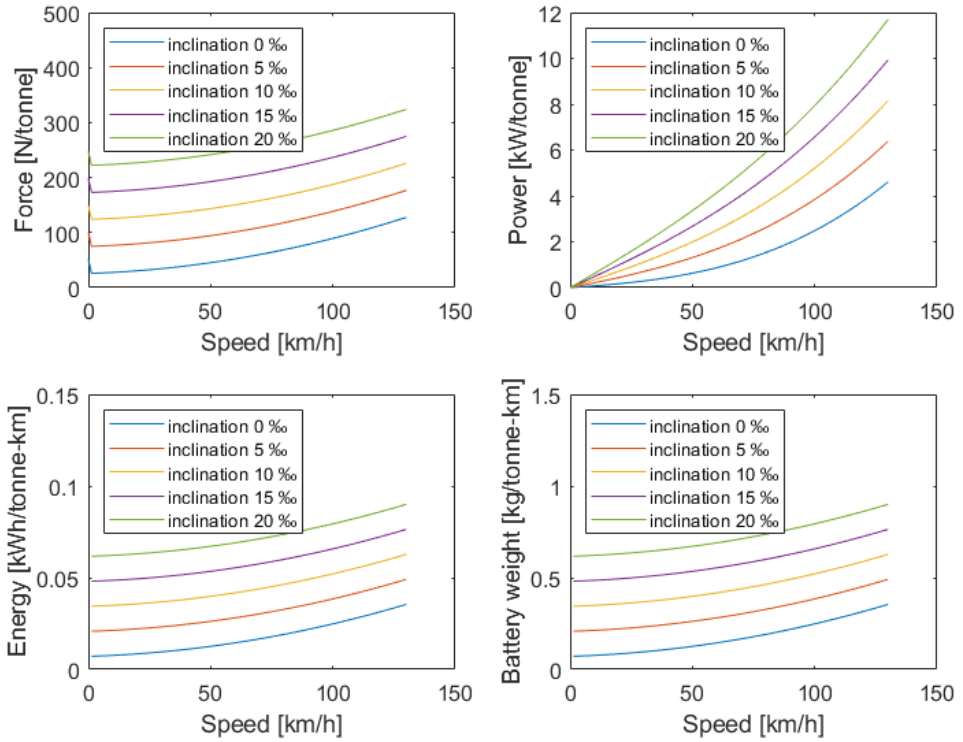
Traction system requirements

Estimation of the powertrain requirements for different use cases

Resistances



Specific powertrain requirements



Traction system requirements

Conceptual scenarios

Scenario A

- Scenario defined by Renfe and CEIT
- in a **700 m track** in around 10-15 minutes, with **no slope** gradient and a **load of 80 tonne**
- between **7 km/h and 20 km/h** to fulfill the time requirements, considering maximum accelerations **up to 0.25 m/s2**
- a peak **torque of 3000 Nm** and a **peak power of 30 kW**
- a **two-motor** approach (one per axle)
- air-cooled motor system
- around **2 kWh**

Scenario B

- Scenario defined by the DLR
- a tractive effort of approximately **30 kN** would be necessary, in particular in order for a **90-tonne** wagon to start from a standstill in an **80 m curve** with a **1.25% gradient**
- maintain a speed of **25 km/h**
- regenerative braking at high speeds
- motor power of **at least 75 kW**
- at least **18 kWh** of energy

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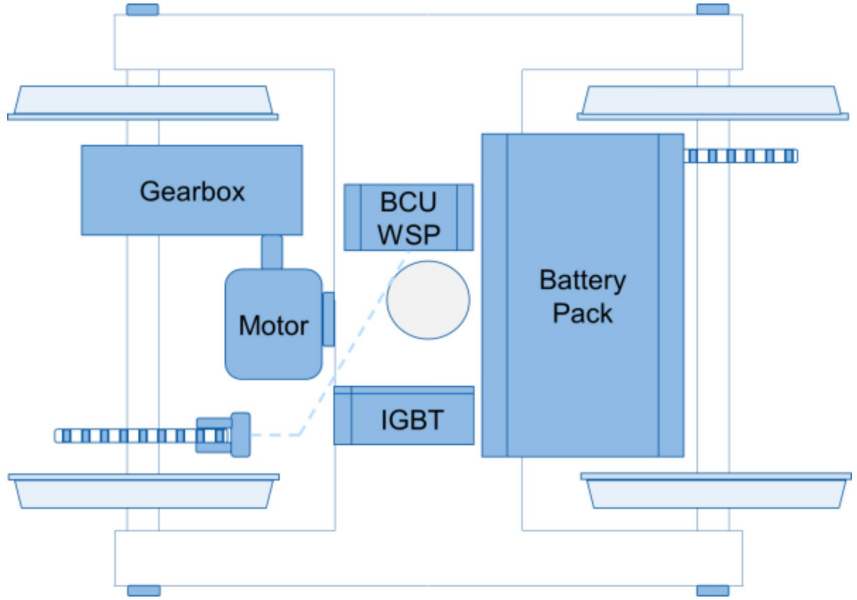
Further considerations

Scenario A

- direct-drive solution
- motor directly coupled to the axle
  - Removing heavy gearbox

=> simplifying the layout and minimizing drag

Conceptual layout of a fully-integrated self-propelled bogie being developed at the DLR for scenario B, with all necessary systems for converting a conventional wagon to an SPFW, including a brake control unit (BCU) and wheel slide protection (WSP)



Scenario B

- high torque requirements
  - Gearbox needed
- lighter, faster turning motor

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Conclusion and further work

- SPFWs: wide variety of use cases

  → Bring different challenges and requirements

- 2 possible configurations:
  - Highly efficient direct drive system, or
  - Highly capable geared drive system
- However, without adding unnecessary cost or complexity to the system

  → Use of standard parts and conventional materials

Major advances in rail freight sector: Digital Automatic Coupler (DAC)

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Thank you for listening!

Do you have any questions?

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