RAILFREIGHT FORWARD
EUROPEAN RAIL FREIGHT VISION 2030
2.0

Green Paper – Rail Freight strategy to boost modal shift

July 10th, 2020

Table of Content

Executive Summary (1/5)

The European Rail Freight sector has committed itself to the goal of 30% rail modal share by 2030

- In 2018, the members of the Rail Freight Forward (RFF) initiative, representing 90% of the European rail freight market, committed to an increase of rail modal share from 18% today to 30% by 2030 in order to neutralize the negative impact of the expected strong growth of the land-based transport market on environment and society (see exhibit 8). Achieving this requires interaction of the three main players – RUs (Railway Undertakings), IMs (Infrastructure Managers) and Authorities
- Meanwhile, the European Commission has proposed the Green Deal with the objective to transform Europe into the first carbon-neutral continent by 2050 and enhance Europe's CO2-emission targets from 40% to 50% by 2030 in comparison to 1990 levels. Adopting the 30% rail modal share would contribute to these targets with 25 m tons of avoided emissions of CO2 equivalents and approximately 25 bn EUR in avoided external costs from 2030 onwards[1]
- The importance of rail freight for the economy was only recently highlighted by the COVID-19 crisis: railway transport proved not only to be safe and sustainable but also to be extremely resilient with rail freight being the only mode of transport, which was not significantly affected by the lockdowns (see exhibit 9).
- The objective of this paper is to explain, how the proposed program outlined below contributes to achieving the targets of the green deal by deploying key technologies for a modern, digitized railway system in Europe - thereby ensuring sufficient capacity and easier access to capacity as well as better products for the benefit of customers and society at large.

Currently, the rail freight sector is not able to deliver the aspired modal shift

- The European rail freight sector is currently not living up to its full potential as all players of the rail freight system face substantial challenges (see exhibit 10). Without major change, the aspired modal shift to 30% by 2030 will not be reached
- The framework for operations of the RUs is not favourable:
  - The Single European Railway Area (SERA) has so far not been realized, yet it is of particular importance for rail freight with 50%[2] of all travel being international. Progress in eliminating the traditional lack of interoperability has been very slow due uncoordinated and delayed deployment of technologies such as ERTMS
  - In comparison to road, infrastructure capacity access and allocation is not adequate for rail freight being a competitive stakeholder in end-to-end supply chain logistics

[1] European Commission, "Handbook on the external costs of transport", (Version 2019 – 1.1)
[2] Source: European Commission, Rail Market Monitoring Report 2020

Executive Summary (2/5)

  - Rail freight is put at a disadvantage in comparison to its main competitor road, as road transport's higher external costs (9.0 ct/tkm vs. 1.3 ct/tkm for rail freight)[3] is borne by society and currently not internalized into transport prices
- However, RUs do not consistently reap the benefits of process automation and digitization, leading to labour intensive working procedures and for certain market segments to an even less competitive cost base with the main competitor road. A majority of rail freight transports meanwhile involves several RUs, which in turn creates challenges due to immature exchange of operational data via bilateral interfaces, low data quality, etc. Hence, rail products do not always meet customer expectations in terms of reliability, transport time, and transparency (e.g., Track&Trace).

To achieve the goal of 30% modal share by 2030, RFF has identified 5 enabling, interlinked technologies which require a coordinated, sector-wide rollout across the EU

- The identified issues lead to the following strategic objectives for the Rail Freight system to support the aspired modal shift (see exhibit 11)
  - RUs offer superior innovative products to seamlessly integrate into the value chain of customers
  - IMs provide sufficient capacity and service that makes running international trains "as easy as running trucks"
  - Authorities provide a level playing field for rail
- These objectives may only be reached by fully leveraging technology in order to enable a stringent automation and digitization of the rail freight processes. The Rail Freight Forward coalition has identified five technologies that are relevant on a system level and should be rolled-out by the entire sector to reap their full benefits
- RUs should fully adopt 3 key technologies until 2030 (see exhibits 11 and 12)
  - Digital Automatic Coupling (DAC): as coupling/decoupling is one of the two main procedures in train operations (train assembly, train driving), its automation is of utmost importance. Europe is trailing the world in this respect, as it is the last continent to use standard manual couplers. We propose to fully deploy the DAC technology latest until 2030 which will significantly improve competitiveness of the rail sector's operations by providing electricity and data bus line across train, automated brake testing, electro-pneumatic brakes, and will enable train consistency checks which is a infrastructural prerequisite required for the introduction of ERTMS level 3
  - Autonomous Train Operations (ATO): Automizing the other main procedure, train driving, is of similar importance. We propose to fully deploy driving with supervision by a driver (Grade of Autonomy (GoA) 2) on long haul and full autonomous train operations without driver (GoA 4) in shunting yards, on the first and last mile, and for fenced-in main line infrastructure. The freight sector aspires to be the first-mover show case for a consistent deployment of this technology in Europe

[3] European Commission, "Handbook on the external costs of transport", (Version 2019 – 1.1)

Executive Summary (3/5)

- Digital Platforms (DP): the sector wants to unlock the true value of the multitude of available operational data by enabling a seamless operational data exchange between all players of Rail Freight Sector via a Digital Platform Ecosystem; in addition, a framework for attracting 3rd parties to drive innovation utilizing these data will be set-up to deliver additional value

- IMs should deploy 2 technologies until 2030, at least on the main international rail freight corridors including deviation routes and access routes to main large customers, terminals and rail ports:
  - ERTMS Level 3 ("moving blocks")[4]: For RUs provisioning of one On Board Unit (OBU) to operate on all main international freight relations equipped with technically harmonized ERTMS level 3 is a prerequisite to avoid investment into several OBUs for individual national legacy systems originating from the current interoperability of rail infrastructure. Only the synchronized rollout of one harmonized ERTMS level 3 with "moving blocks" can provide the significant capacity improvements on the same track superstructure needed to accommodate the projected rail freight growth
- Digital Capacity Management (DCM): fast access to transparent and dedicated rail freight infrastructure capacity requires a step-change from assemble-to-order processes to automated and digitized train path construction and allocation. This is also paving the way to real-time capacity management (infrastructure operations).

The deployment of these key enabling technologies will provide strong benefits to customers in terms of rail freight product quality, cost reduction, available capacity, and improved working conditions until 2030

- According to exhibit 13, the selected technologies consistently contribute at various levels to the main requirements for an enhanced modal share of rail: higher RU product quality, cost reduction, and better utilisation of available infrastructure capacity in order to accommodate the projected rail freight volume growth. In addition, employees in the rail freight sector will benefit from substantially improved working conditions
- The 5 technologies will allow RUs to provide better rail-based transport (see exhibit 14). This should lead to a significant increase in reliability due to more infrastructure capacity, fewer track-side signalling failures, much better visibility of shipments due to enhanced European-wide data transparency, and ultimately better resource utilization in driving and coupling. Fairer capacity allocation between infrastructure users, better international train paths with less stops, and higher maximum speed due to EP-braking will allow for shorter transport times, esp. for block train-based products like intermodal. Lastly, customers will finally experience the expected transparency on booking and shipment status due to the improved booking of train paths, European-scale Track&Trace and ETA (Estimated time of arrival), and the seamless integration of transport chains via DP

[4] European Rail Traffic Management System of which ETCS (European Train Control System) is one of the components along with GSM-R (dedicated railway communication system) and ETML (European Traffic Management Layer)

[5] S2R: combined effect of ERTMS Level 3 with ATO 50%; expert estimate of additional effect of ATO in case of ERTMS Level 3 "moving blocks": 10%

[6] DB Netz

Executive Summary (4/5)

- Deployment of the key technologies will allow for strong capacity increase by approximately 54% on current track superstructure without construction of entire new lines (see exhibit 16). The main contribution to this increase originates from ERTMS level 3 with approx. 40%[5], followed by ATO with approx. 10%, and DCM with approx. 4%[6]. The impact of DAC can currently not yet be quantified
- Working conditions in the rail freight sector will be significantly improved through more ergonomic working conditions, higher safety for personnel, and higher attractivity as employer (see exhibit 17)
- We expect the proposed program to significantly contribute to achieving the goals of the green deal with an avoidance of 25bn EUR external costs annually from 2030 onwards
- We expect the cost of rail transport to decrease by on average 10-15%[7] until 2030 (see exhibit 15). This order of magnitude is indicative as RUs have widely differing cost structures and projected savings per cost category vary between 5% for wagons and 30% for locomotives. Given the high level of intermodal and intramodal competition, we expect that a substantial share of these cost benefits will go to the market, i.e., cannot be used to finance the R&I and deployment of these technologies. Since road transport can be expected to reap equal to even higher cost savings, the proposed program will not enhance the relative cost position of rail freight. Introduction of an adequate CO2-pricing scheme to reflect the real costs of transportation across all modes of transport is therefore advisable.

Deployment of the key technologies requires investments of roughly 18 bn EUR until 2030 and funding by the EU

- The overall investment need for freight RUs, subject to public funding of 18 bn EUR in the time frame of 2020 – 2030, is mainly driven by DAC with ~12.0 bn EUR and the ERTMS OBUs with ~5.0 bn EUR[8]. The remaining 3 technologies DP, ATO, and DCM require in total "only" ~1.0 bn EUR (see exhibit 18). The five technologies can be grouped in 3 categories relating to different rationales for the need of public funding:_
  - DAC (~12.0 bn EUR)[9] along with DP (~0,4 bn EUR)[10] require a coordinated deployment across the whole network in order to reap full benefits (see exhibit 19). This requires a robust governance mechanism at European level to ensure full adoption along with substantial public financing on the European level due to the high investment requirement, the long lead-times of benefits (only after migration of a large part of the wagon pool for DAC), along with the low financing capacity of the sector due to a current lack of profitability

[7] Rough business case based on the combined effects on the cost positions of freight RUs (track, energy, locomotives, drivers, wagons, stations). For details on assumptions refer to the appendices of the main documentation
[8] Work Plan 2020 if the European Coordinator for ERTMS, May 2020
[9] Development of a concept for the EU-wide migration to a digital automatic coupling system (DAC) for rail freight transportation" Final Report to the Federal Ministry of Transport and Digital Infrastructure (BMVI) in Germany, 29.6.2020
[10] Estimate of the working group

Executive Summary (5/5)

- ATO requires a continuation within the successor S2R for R&I along with financing of "first mover" showcase pilots. Proper deployment of ATO has the potential to allow RUs to finance deployment through expected savings (see exhibit 19)
- ERTMS Onboard units (~5.0 bn EUR) and DCM (~0,5 bn EUR)[11] are equivalent to investments in new physical infrastructure while being a lot more efficient (less lead-time at significantly lower costs at an order of magnitude of 5-10%[12]) (see exhibit 20). According to current financing logic, they should therefore be borne by society.

For successful deployment of the enabling technologies, the governance must be articulated around strong R&I and a robust deployment mechanism

- In light of the past deployment track record of technologies in the rail sector (example ERTMS), the Rail Freight Forward Initiative believes that robust governance mechanisms are needed (see exhibit 21)
- With respect to the set-up of the Shift-2-Rail successor as the future R&I vehicle for the sector, Rail Freight Forward calls for the following prerequisites to be fulfilled:
  - Within the proposed System pillar a dedicated freight representation
  - Participation of the whole rail freight sector in S2R, esp. smaller RUs and IMs via differentiated roles
  - Proposals for specifications/ standards need to be developed and approved with strong involvement of the System Pillar
- Most of the available public funding will be required for the deployment phase. A dedicated deployment governance is therefore indispensable to ensure the successful transformation of the rail (freight) sector. The deployment governance needs to be built around a supplier/customer relationship between the sector/society and supplying industry. Furthermore, the governance of the deployment phase must reflect the fundamental differences between R&I and deployment (e.g., different (roles of) stakeholders, different sources for financing). Mechanisms should amongst others include deployment regulation, deployment planning aligned with the sector, frequent deployment monitoring and escalation, financial incentives to adhere to agreed deployment plans, etc.

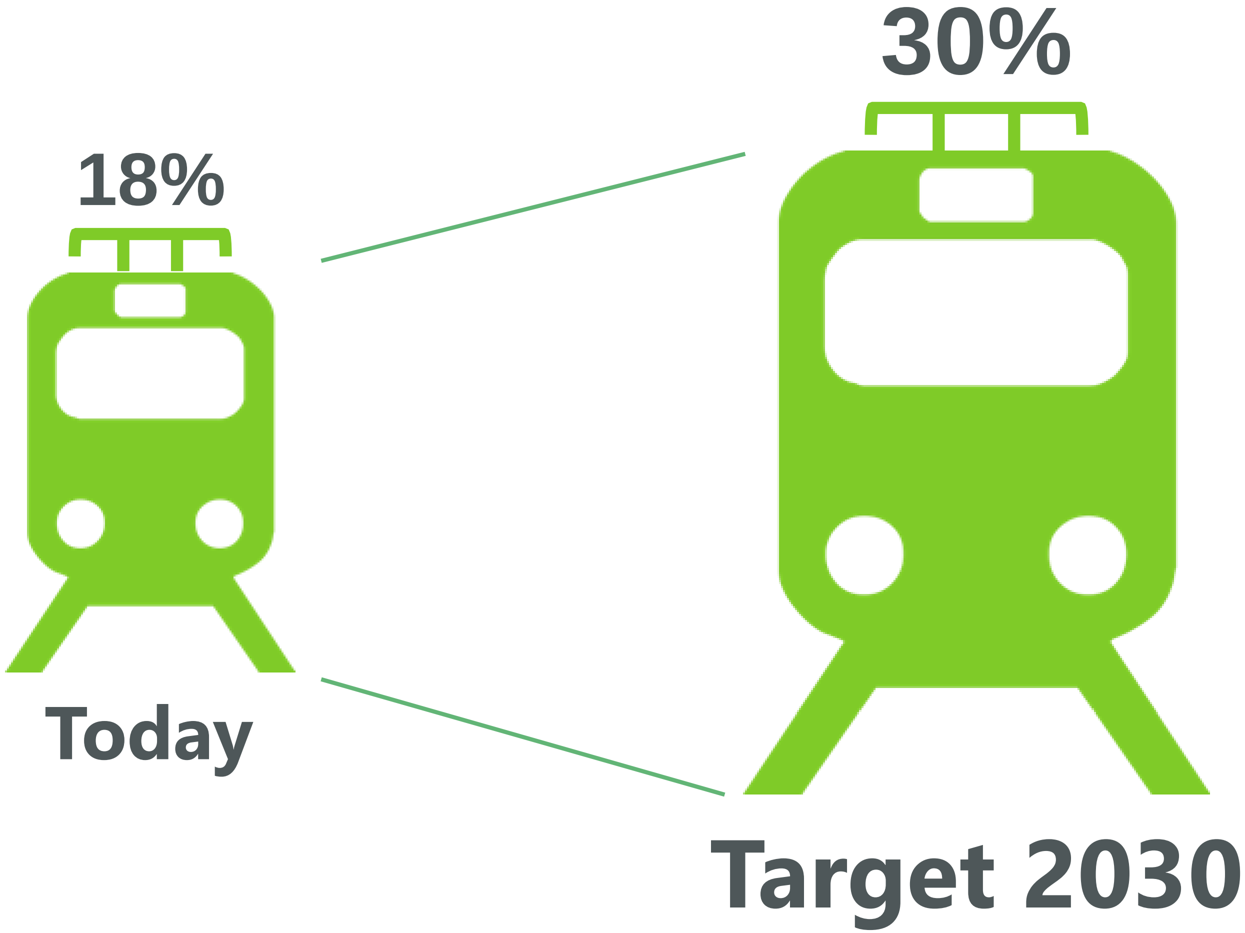
This sector program relying on the engagement of the entire rail sector and authorities is the cornerstone for delivering the aspired modal share of 30% by 2030

[11] RNE document of project "Redesign of the international time tabling process (TTR): TTR migration concept and IT landscape, 20.5.2020
[12] Rough calculation for illustration purpose: 40% additional capacity on 25% of the European network (ambition of ERTMS rollout) at 3 Mio. EUR per km would cost roughly 80bn EUR initial investments; continuous maintenance not considered

Table of Content

The European rail freight sector has committed itself to the goal of 30% rail modal share by 2030

Rail modal share, EU



Impact 2030

- Shift towards more sustainable transport in Europe
- Supporting EU environmental targets: At least 50% reduction of CO2-emissions by 2030 compared to 1990[1]

€ 25 bn EUR reduction in external costs p.a.

CO_2 25 m tons p.a. along with less accidents and air pollution

[1] According to Green Deal proposal

The COVID-19 crisis has highlighted the need for a reliable and sustainable transport backbone for the European economy

Press releases during COVID-19 crisis

Difficulties of road

Mega traffic jam at border to Poland
rbb24, 21.05.2020

Trucks are forming 37-mile-long queues at European borders after authorities started closing them to stop the coronavirus spread
Businessinsider.com, 18.03.2020

Stability of rail

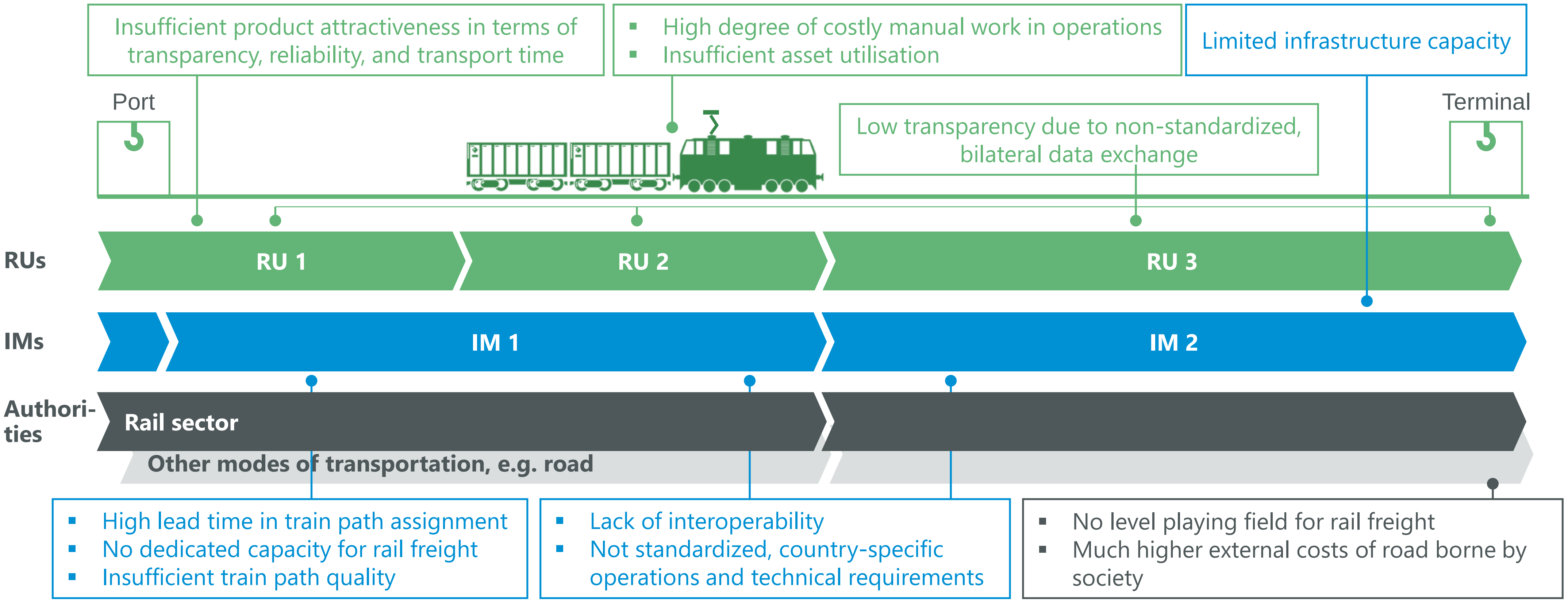
Battle against empty shelves – DB Cargo starts pasta express from Italy
Handelsblatt, 19.03.2020

Corona virus – Rail is proving its worth beyond its green credentials. It deserves support
Railway News, 19.05.2020

RAILFREIGHT FORWARD
EUROPEAN RAIL FREIGHT VISION 2030

With the current setup, the rail sector is not able to deliver the aspired modal shift

Challenges

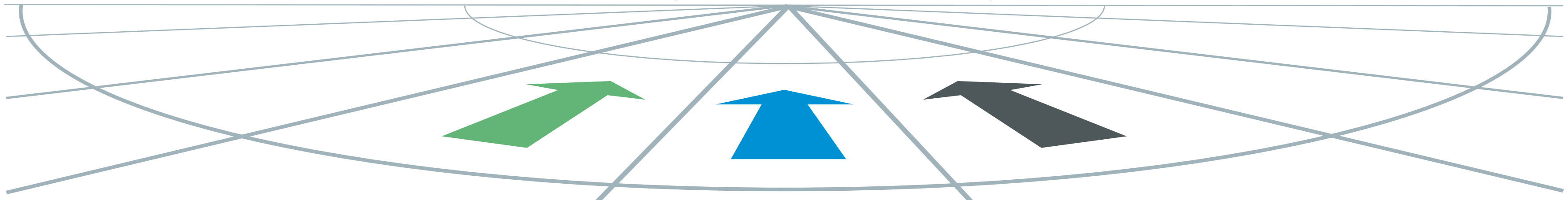


RAILFREIGHT FORWARD

The RFF coalition has committed to a rail model share of 30% by 2030 for which implementation of enabling key technologies is needed

Fields of action – Rail Freight Forward

30% rail freight modal share by 2030



1

RUs offer superior innovative products to seamlessly integrate into the value chain of customers

Automation and digitization
- Digital Automatic Coupling (DAC)
- Digital Platforms (DP)
- Autonomous Train Operations (ATO)

2

IMs need to provide sufficient capacity and service that makes running international trains "as easy as running trucks"

Technical harmonization, digitization and capacity expansion
- Harmonized ERTMS Level 3 rollout
- Digital Capacity Management (DCM)

3

Authorities need to provide level playing field for rail

Ensuring a level playing field, provision of financing
- R&I
- Deployment

5 interlinked key technologies are prerequisites for substantial modal shift

Key technologies required for modal shift

Digital automated coupling (DAC)

- Automated coupling/ decoupling of assets
- Electricity and data bus line across train
- Automated brake test
- EP brakes
- Train consistency check

ERTMS

- One On Board Unit (OBU) to operate on main international freight relations equipped with technically harmo-nized ERTMS level 3

Autonomous Train Operation (ATO)

- Autonomous driving with supervision by driver (GoA[1] 2) on long haul
- Autonomous driving without driver (GoA 4) on last mile/shunting yards

Digital Capacity Management (DCM)

- Step-change to automated and digitized train path construction and allocation
- Dedicated freight capacity
- Fast access to (inter-)national train paths with higher quality
- Expansion to real time capacity management (infrastructure operations) at later stage

Digital Platforms (DP)

- Creation of digital ecosystem for seamless operational data exchange between all players of Rail Freight Sector
- Innovation platform for 3rd parties

Full potential only reaped with coordinated, sector-wide rollout of all technologies across all geographies

[1] GoA = Grade of autonomy

These key technologies provide strong benefits in terms of product quality, cost reduction, and available capacity

Benefits of key technologies to rail

	Enabler	DAC	DP	ATO	ERTMS	DCM
A Higher RU product quality	RU	▪ Faster delivery, higher reliability and lower cost	▪ Seamless operational data exchange across countries/companies	▪ Higher reliability (~15%[2] higher punctuality)	▪ Higher punctuality due to less failures of trackside signalling	▪ ~-6%[1] travel time, better reliability (train path quality), instant capacity check, dedicated freight capacity
B Cost reduction	RU/IM	▪ Improved utilization of personnel and assets	▪ Reduction of manual data gathering efforts, better utilization of wagon/train capacity	▪ ~10%[3 4] lower cost for energy (GoA 2), reduced need for drivers in shunting and first/last mile	▪ Decrease of infrastructure maintenance costs	▪ Improved utilization of rolling assets and drivers (up to ~15%[3]) and rail path engineers
C Better utilization of available infrastructure capacity	IM	▪ Higher speed, enabler for ERTMS level 3, more capa-city in marshalling yards/terminals	▪ Optimized utilization of wagon capacity	▪ ~10%[2 3] on top of moving blocks (optimized distance between trains)	▪ Level 3 moving blocks: +~40%[2 3]	▪ ~+4%[1] through optimized rail path planning/assignment
D Better working conditions	RU/IM	▪ Higher safety and more ergonomic working conditions		▪ Reduction of on-train operations and better utilization of bottleneck resource driver	▪ Higher safety	

[1] DB Netz [2] S2R [3] Expert interviews [4] ÖBB
[2] GoA = Grade of autonomy; GoA 2 supervision by driver, GoA 4 without driver

Deployment of key technologies will strongly enhance RU product quality

A. Impact on RU product quality

NOT EXHAUSTIVE

Transparency

- Improved booking of train paths ("one-stop shopping")
- Availability of dedicated, systemized rail freight capacity
- Seamless integration of transport chains via Digital platforms
- Seamless Track & Trace

Transport time

- Significantly reduced transport times due to
  - Dedicated freight capacity bands with less disruptions
  - Better train paths

Reliability

- Higher punctuality
  - Less trackside signalling failures (ERTMS 3)
  - Less congestion due to significantly increased capacity
- Better synchronisation across Europe through data transparency
- Less dependency on critical bottleneck resources (DAC, ATO)

Substantial increase in demand expected

The cost base of rail transport is expected to decrease by ~10-15% – economies of scale due to modal shift not taken into account

B. Impact on cost position rail freight[1]

in %, cost base 2020 – no economies of scale assumed[2]

Remaining cost
Cost optimization

	Cost optimization	Description of levers
Train path	~25%	▪ Capacity increase on network (Offer: ERTMS L3, DCM; Demand: ATO, DAC, DP) ▪ Reduction of maintenance costs through decommissioning of Class B (ERTMS)
Energy	~20%	▪ More homogeneous driving (ATO) ▪ Better rail paths with less stop and go (DCM) ▪ Better utilization of wagon capacity (DP)
Locomotive	~30%	▪ Higher transport efficiency due to longer trains (DAC) ▪ Better utilization of assets and drivers due to faster rail paths (DAC, DCM) ▪ Higher transport efficiency due to better utilization of wagon capacity (DP)
Driver	~30%	
Wagon	+5%	▪ Higher efficiency due to better utilization of wagon capacity (DP) ▪ Better utilization of assets due to faster rail paths (DAC, DCM)
Stations	~10%	▪ Reduction of manual work (DAC) ▪ Better utilization of driver (ATO GoA4 in shunting) ▪ Higher productivity of stations due to better planning (DP)
Total	**~10-15%**	▪ **New cost basis prior to growth**

- The savings assume full implementation of the proposed measures
- Given the high level of intermodal and intramodal competition, substantial share of cost benefits will go to the market
- Other modes of transport can be expected to reap similar cost savings - the proposed program will therefore most likely not significantly enhance the relative cost position of rail freight
- Higher market share of rail requires a level playing field in addition

[1] Assumption: Deployment of DAC Type 4

[2] Assumption: Enough demand to use free capacity and therefore enable better cost per rail path on same physical network

ATO: Automatic Train Operation; DCM: Digital Capacity Management; DP: Digital Platform; DAC: Digital Automatic Coupling

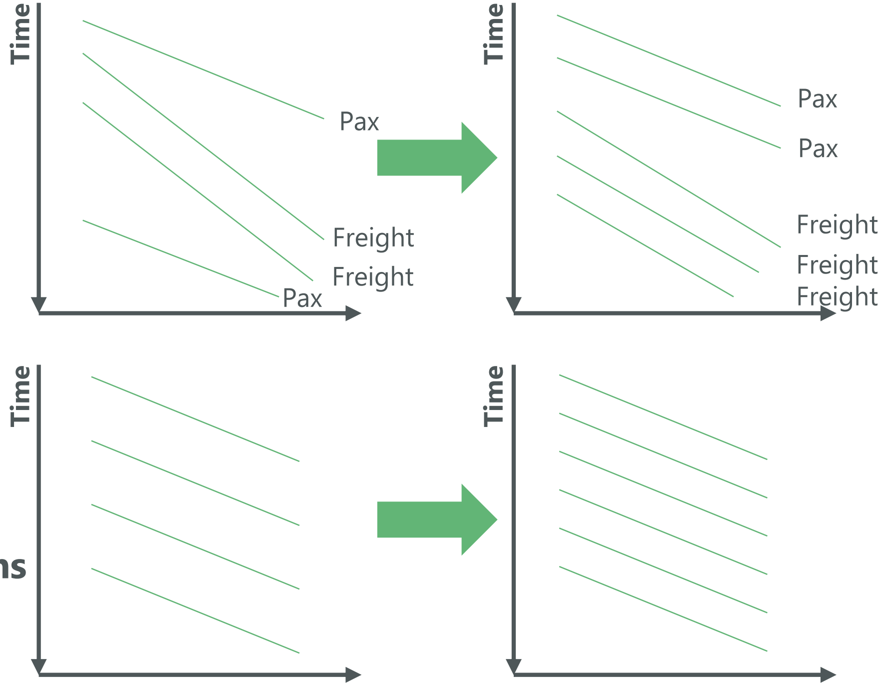
RAILFREIGHT FORWARD

Deployment of key technologies allows for strong capacity increase on current track superstructure without construction of entire new lines

C. Impact on infrastructure capacity
in % of current no. of train paths

Train path harmonization and bundling

Reduction of headroom bet-ween train paths



- Infrastructure capacity increase on current track superstructure prerequisite for modal shift
- Measures could provide large share of new capacity required for 30% modal share of rail
- Train path harmonization and bundling allows for dedicated rail freight capacity bands

[1] With ETCS Level 3, substantially lower for Level 2

The working conditions in the rail freight sector will be significantly improved

D. Impact on working conditions

Improved working conditions

- More ergonomic working conditions due to less heavy lifting
- Decrease in long-term health issues caused by physical stress
- Reduction of low-skilled tasks to be performed outside in all weather conditions

Higher safety for personnel

- Avoidance of potentially risky tasks (esp. manual coupling)
- Monitoring of safety conditions by technology

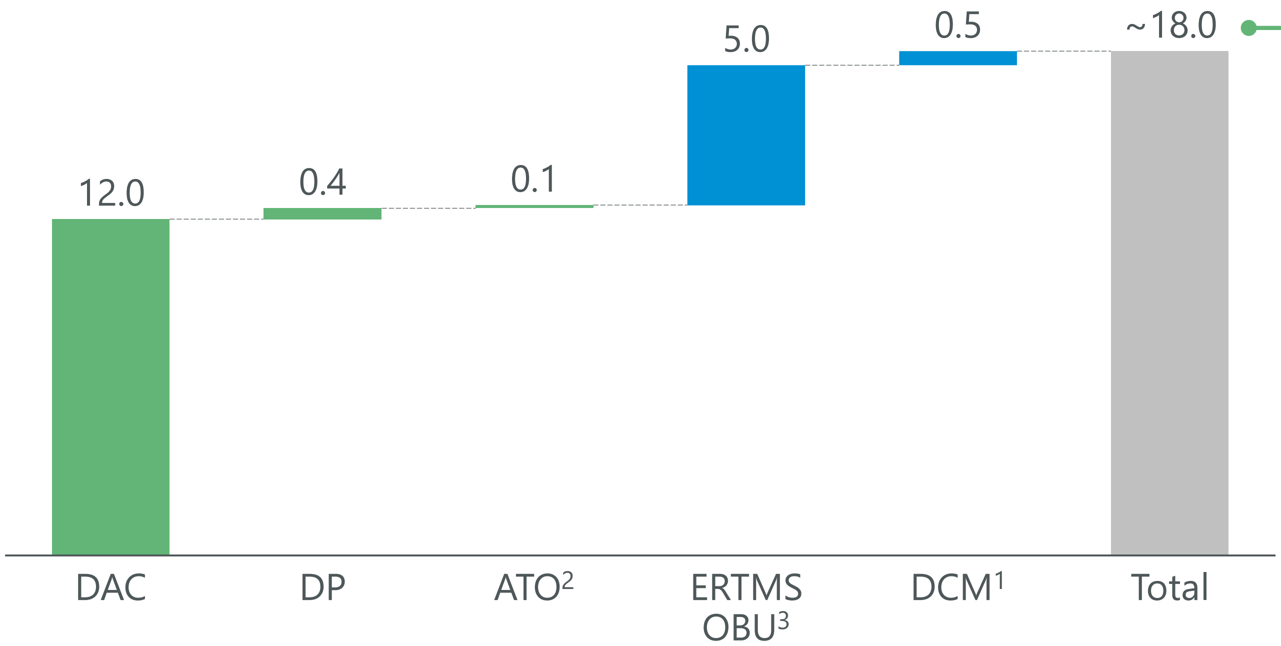
Higher attractivity as employer

- Job profiles dealing with current technologies
- Need for new digital skills

Deployment of the key technologies requires investments of approximately 18 bn EUR until 2030 and requires substantial funding

Investment requirements 2021 – RU perspective[1]

in bn EUR



Benefit

Annual avoidance of external costs: 25 bn EUR from 2030 onwards

Deployment funding

DAC, DP	ATO	ERTMS OBU, DCM
Sector subsidy and robust governance to ensure full deployment	Pilot funding	EU/state infrastructure funding

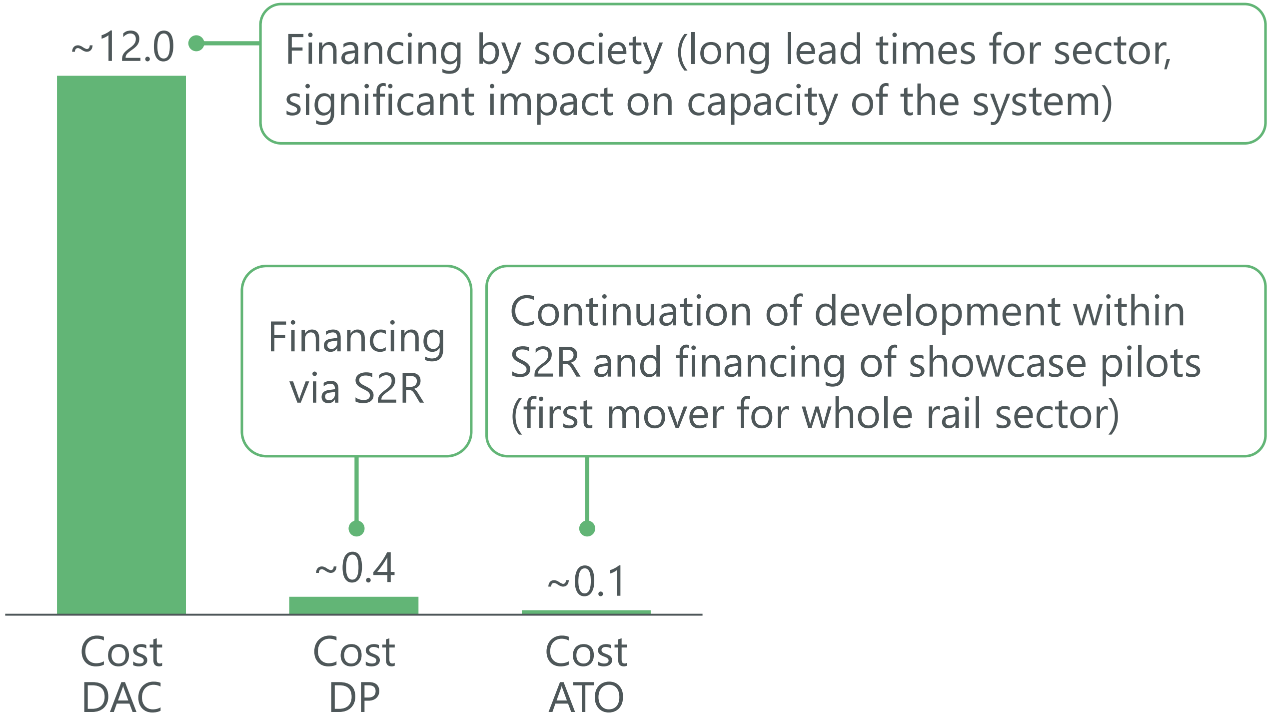
[1] DCM funding required for IM
[2] "S2R 2" for R&I
[3] Without investment in fixed infrastructure at level of IMs

Without public financing the sector will not be able to fully adapt "mandatory" sector technologies DAC and Digital Platform

Funding of "mandatory" sector technologies
in bn EUR

Rationale

- Higher attractiveness of rail freight offering through mandatory, standardized technology platforms
- Clear and uniform regulation for deployment needed to ensure full rollout – DAC only differentiating as a network feature on sector scale, not as stand-alone for individual player
- High level of competition and cash constraints of sector strongly limits investment capabilities

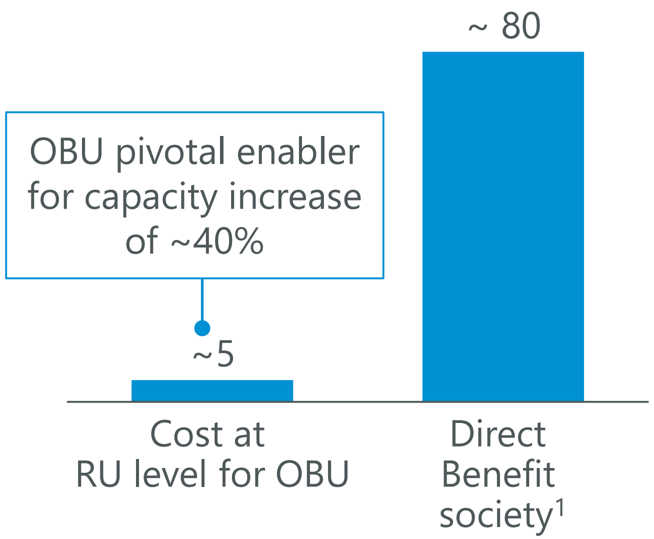


Providing the required infrastructure capacity is responsibility of EU and member states

ROUGH ESTIMATES

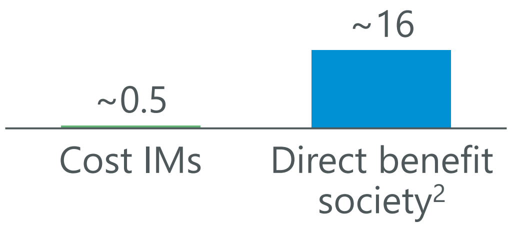
Funding of infrastructure capacity
in bn EUR

ERTMS OBU



- OBU in ERTMS part of infrastructure
- Enabler for capacity increase of 40% (Level 3)
- For migration period, double equipment of locs cheaper than double equipment of infrastructure with ERTMS and Class B systems

Digital Capacity Management



- Digital Capacity management instead of investment in additional physical capacity

Full funding required by EU and member states

[1] 40% capacity increase on 25% of the network (ambition of ERTMS roll-out until 2030) at 3mio EUR/km cost for physical new capacity. Network length of 270.000km assumed.
[2] 4% capacity increase on 50% of the European network with otherwise same assumptions

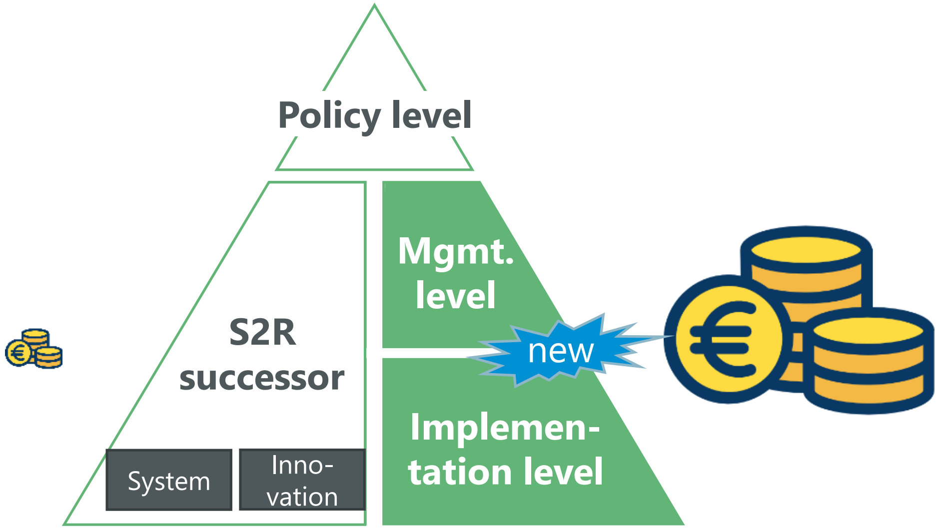
For successful deployment of technologies, the governance must be articulated around strong R&I and a robust deployment mechanism

Governance requirements for successful deployment

Required funding

Requirements from freight's perspective for S2R successor

- Participation of the whole sector in S2R, esp. smaller RUs and IMs via differentiated roles
- Within the proposed System pillar a strong, dedicated freight pillar with adequate representation of RFF
- Proposals for specifications/ standards need to be developed and approved with strong involvement of the System Pillar



R&I phase: S2R-successor ("Transforming Europe's Rail System")

Deployment phase: New dedicated governance

TLR[1]	0 - 9	>9

Setup of governance for deployment phase

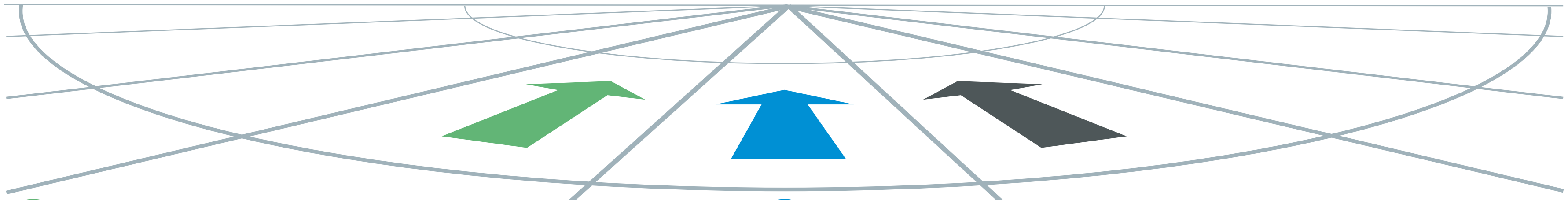
- Deployment governance should reflect the fundamental differences to R&I
  - Supplier/customer relationship between industry and rail sector in deployment
  - Different recipients of EC funds
- Required mechanisms include, e.g.,
  - Deployment regulation
  - Deployment planning/ monitoring
  - Decision making
  - Financial incentives

[1] Technology Readiness Level; TLR 9 = System ready for full-scale deployment

Beyond implementing the key technologies, further prerequisites needed for 30% modal share of rail freight by 2030

Fields of action – Rail Freight Forward

30% rail freight modal share by 2030



1

RUs offer superior innovative products to seamlessly integrate into the value chain of customers

Automation and digitization
- Digital Automatic Coupling (DAC)
- Digital Platforms (DP)
- Autonomous Train Operations (ATO)

\+

- Full digitisation of processes
- More attractive rail freight products

2

IMs need to provide sufficient capacity and service that makes running international trains "as easy as running trucks"

Technical harmonization, digitization and capacity expansion
- Harmonized ERTMS Level 3 rollout
- Digital Capacity Management (DCM)

\+

- 740 m train length, PC 400
- Removing language barriers
- …

3

Authorities needs to provide level playing field for rail

Ensuring a level playing field
Provision of financing
- R&I
- Deployment

\+

- EU CO2 pricing scheme to internalize external costs

This ambitious program has been aligned with a broad representation of stakeholders from the rail freight sector

Table of Content

Current rail freight operations face a low degree of automation and do not capture the full potential

Main rail freight products and current challenges

Main rail freight products

Single wagon load

Origin/ pick-up | Train run | Marshalling yard | Train run | Destination

Block train

Origin | Train run | Destination

Combined transport

Transshipment | Train run | Transshipment

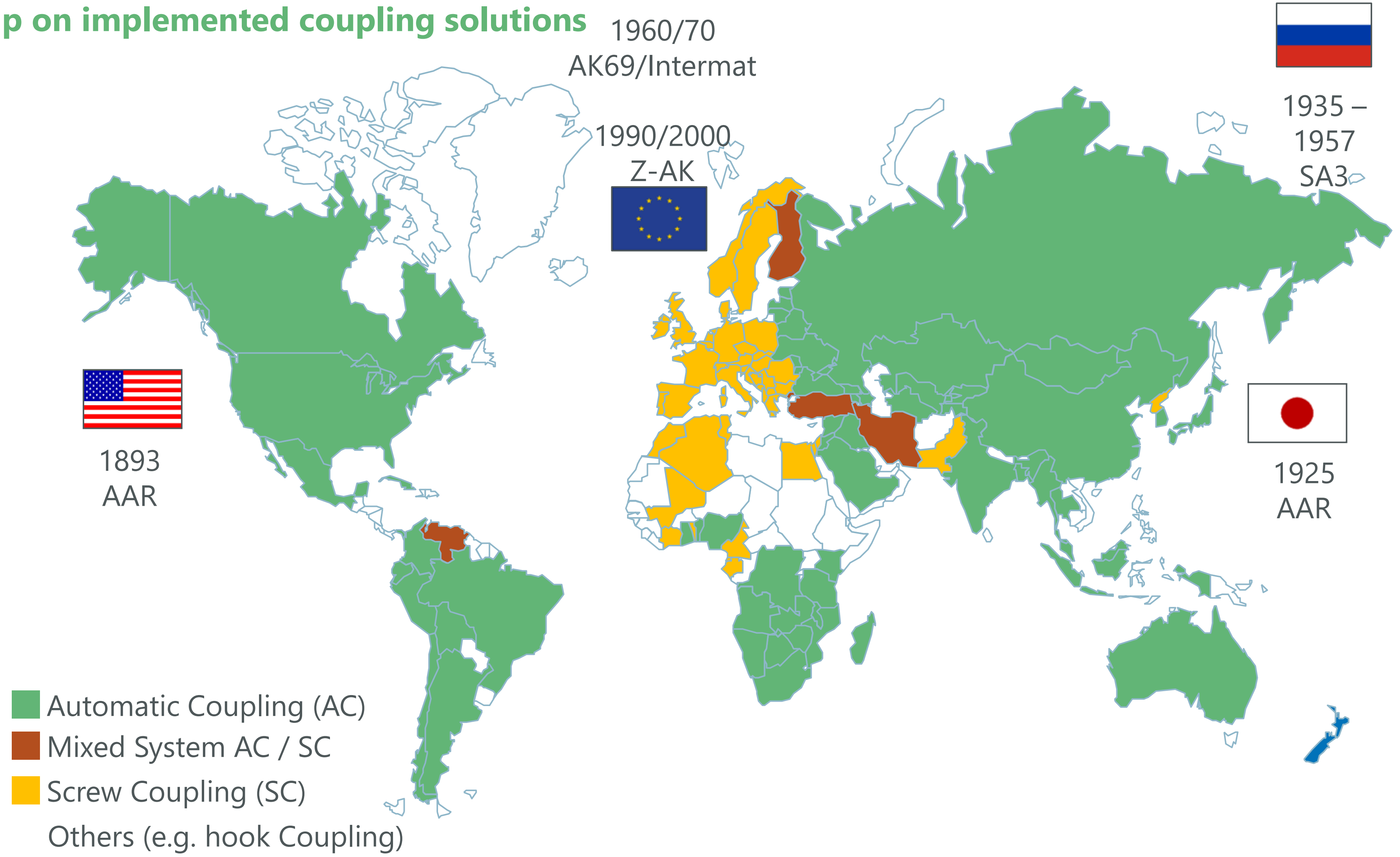
Challenges

- **High degree of manual work** (e.g., de-/ coupling, wagon inspection, brake test) negatively impacting reliability and cost competitiveness of products
- Physically demanding **working conditions and safety** issues decreasing attractiveness of employers
- **Non utilized potential in operations** e.g., for longer/ heavier trains **and automation in interfaces** with customer sites, terminals, and ports hamper reaping full benefits of rail freight system
- **Lack of basis for innovative developments** such as ERTMS[1] and smart applications (requiring electricity and data transfer) preventing further growth and customer satisfaction

[1] ERTMS Level 3 "moving blocks" requires automatic train integrity test which is part of DAC

Europe could be the first continent where Digital Automatic Coupling (DAC) becomes the standard

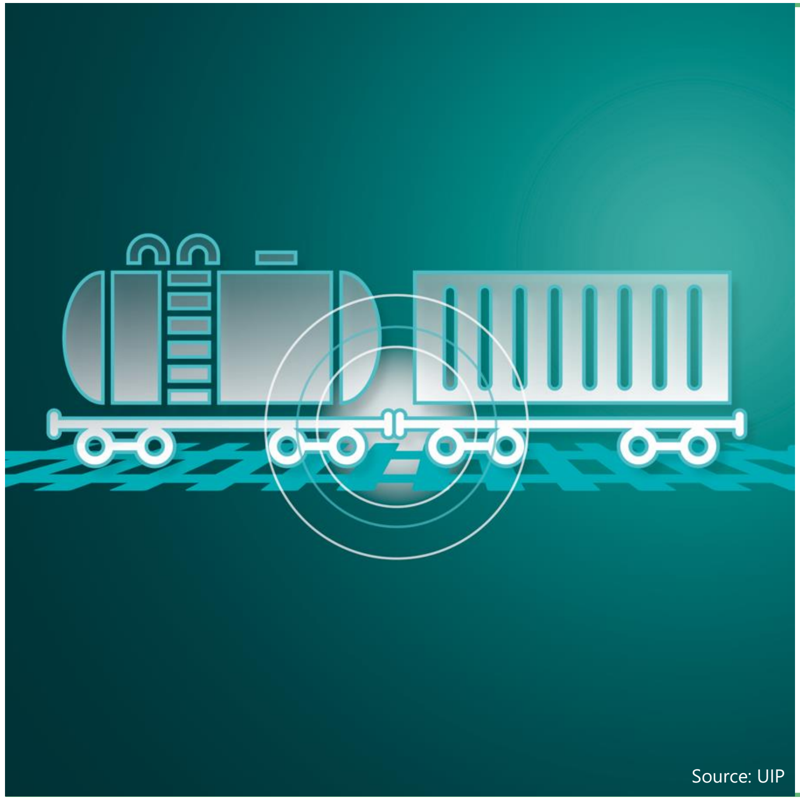
World map on implemented coupling solutions



Source: hwh

The European rail freight sector envisions a step-change in competitiveness via the rollout of the DAC

Vision



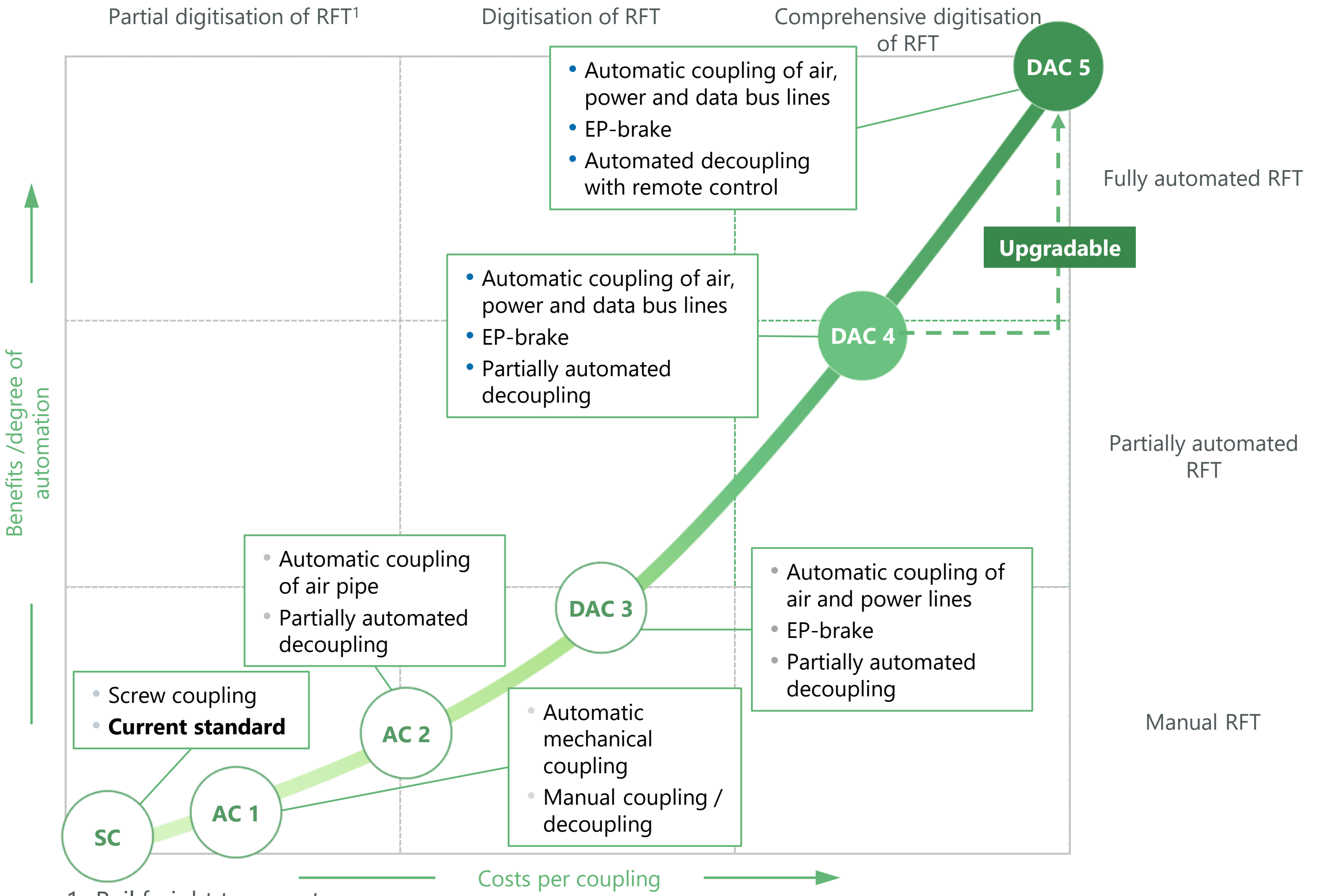
Source: UIP

The European rail freight sector envisions a step-change in its competitiveness through the rollout of the DAC by

- Offering better and more reliable products with higher quality to customers,
- Increasing the degree of automation in operations and enabling future innovation for RUs,
- Increasing the market volume for wagon keepers and developing new services for customers
- Better utilizing limited rail infrastructure through increase of capacity and decreasing infrastructure costs for IMs
- Increasing degree of automation and operational efficiency at customer sites, ports, and terminals
- Contributing to the well-being of society by reducing external cost

To accomplish the vision, a EU-wide rollout of the DAC type 5 is required in the final stage

Functionalities and corresponding DAC types



1 Rail freight transport
2 Different prototypes with different technical solutions are available
Source: hwh

Choice of DAC type

- DAC type 4 provides highest degree of functionalities currently available[1] (testing ongoing) and is upgradable to type 5 via update at later stage
- DAC type 4 consists of
  – physical automated coupler
  – and is enabler for electricity and data bus line, automated brake test, and electro-pneumatic (ep) braking
- Upgrade to DAC type 5 (incl. remote-controlled automated decoupling) as evolution to DAC type 4 in parallel stream
- Other (D)AC types provide insufficient automation and enabling potential for future operations

DAC is a key game changer for significantly upgrading the performance of the whole rail sector

ESTIMATES

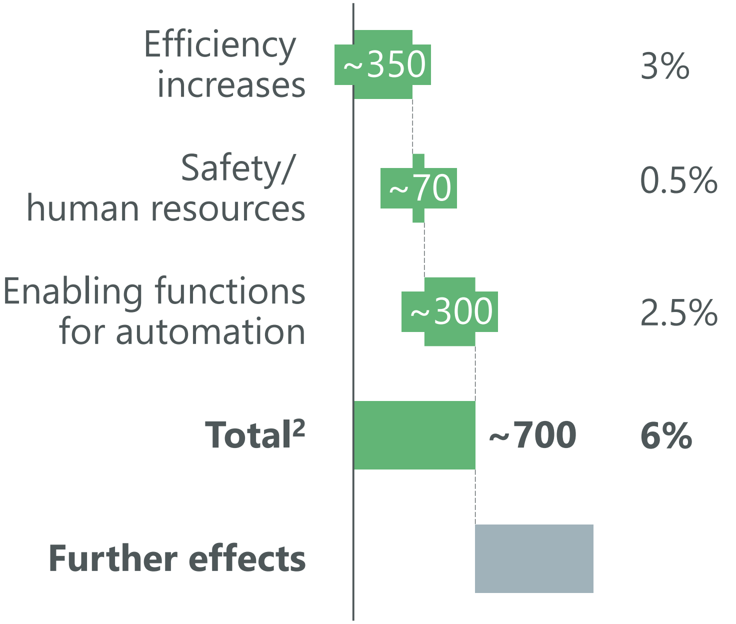
Benefits of DAC type 4 for the rail sector

DAC is a key game changer for the whole rail sector...

- **Increase of up to ~40% capacity in marshalling yards**[1], as well as capacity increase in terminals and ports once fully implemented
- **Direct effect network capacity**
  - **Faster trains** due to EP brake
  - **Heavier/longer trains** as DAC can stand higher forces
- Indirect effect on network capacity: **enabler for ERTMS Level 3** "moving blocks" (train integrity tests), ERTMS Level 3 **estimated with 40% capacity** increase on same physical network
- **Addressing personnel shortage** in marshalling yards

...and also adds substantially to the competitiveness of rail freight

Annual savings for entire rail freight sector as of completed rollout of DAC type 4, in m EUR at constant volumes and percentage of total costs



- Heavier trains
- Increase in operations speed
- Reduction of shunting work

- Reduction in recruiting expenses
- Occupational safety for personnel

- Automated brake test
- EP brake
- Automated train integrity check

- Current values conservative and not complete estimates, which require further elaboration within European DAC Delivery Programme

First estimates – further elaboration of effects within the European DAC Delivery Programme

[1] Estimate of a study by DB: "Die Digitale Automatische Kupplung (DAK) aus Sicht der DB AG"
[2] Average benefits for Germany scaled up on European level by means of transported tkm and national price indices, Source: hwh

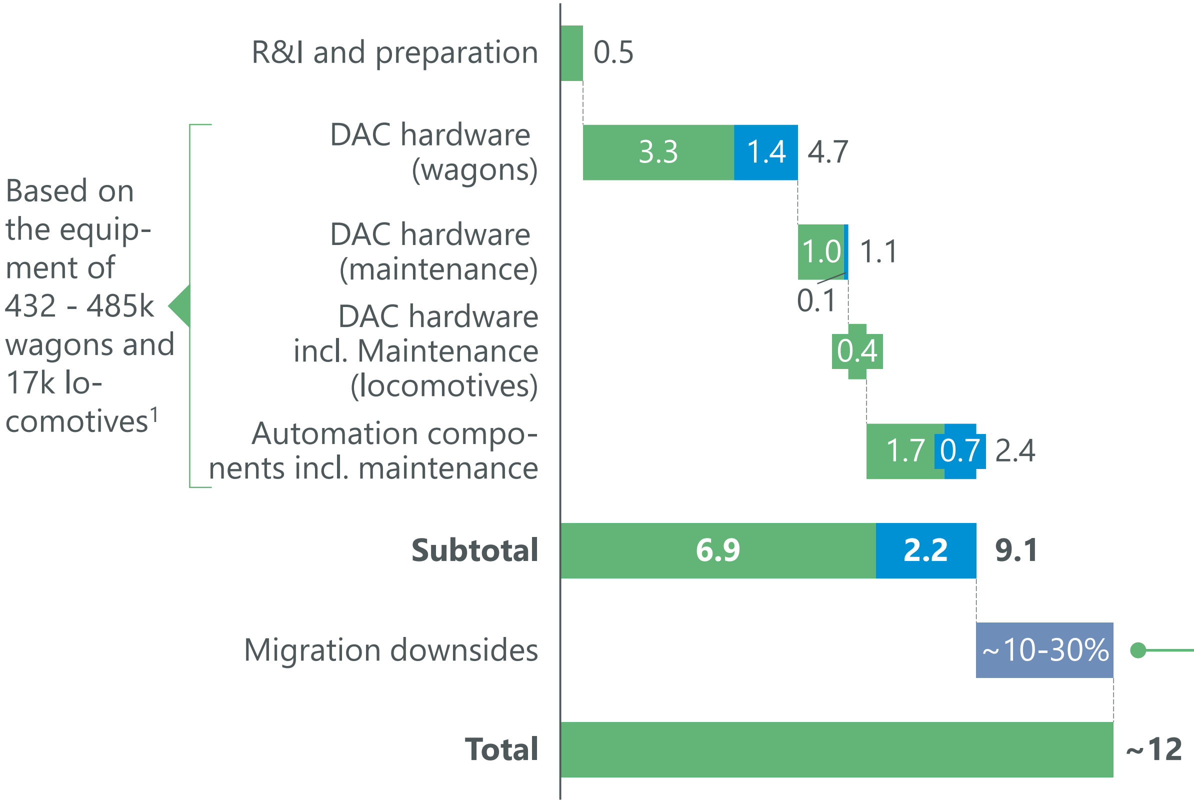
RAILFREIGHT FORWARD

The overall costs associated with the deployment of the DAC are estimated at 12 bn EUR

ESTIMATES

Cost breakdown of migration to DAC type 4, in bn EUR

Minimum estimate
Additional risk



Description

- Research on and specifications for DAC type 4 and 5
- Sector-wide preparation of migration
- 8-10k EUR hardware costs per wagon
- 2.5k EUR for retrofit per wagon
- 4-5k EUR per wagon

Migration downsides can be substantial and include

- Inefficiencies in dispatching due to dual operations during migration phase (congestion in marshalling yards in case of two parallel systems; loss of load factor in case of coupler wagons)
- Revenue loss (lower asset productivity, less flexibility in allocation of transport capacity)

Concrete migration strategy still needs to be elaborated in the framework of the European DAC Delivery Programme

First estimates – further elaboration of effects within the European DAC Delivery Programme

[1] Source: hwh, preliminary figures based on technical solutions of prototypes; final costs may vary
[2] Rough estimate strongly depending migration scenario and operating model; to be specified under European DAC Delivery Programme

RAILFREIGHT FORWARD

A joint, EU-wide approach towards migration is an absolute prerequisite for the success of the DAC

Phases

Organizational set up

- Establish sector-wide open working group with clear mandate for DAC
- Synchronize ongoing efforts on DAC
- Develop sector-wide high-level roadmap and timeline

Until 2020

Preparation for migration

- Develop pan-European and national business case
- Testing of DAC prototypes (demonstrators)
- Finalize technical specifications and homologation of DAC
- Develop and commit to concrete deployment plan and strategy incl. operating model during and after migration
- Define concrete financing schemes and secure funding

2020 - 2023

Deployment/migration

- Deploy DAC
- Coordinate and monitor migration efforts within sector to minimize operational challenges

As of 2023

Work packages specified under European DAC Delivery Programme (Preparation for migration)

Deployment in dedicated governance (Deployment/migration)

The deployment of the DAC requires substantial public financing

Requirements for successful implementation of DAC

General requirements for DAC program	
Continu-ation of deve-lopment	▪ Continue the DAC program within the framework of the European DAC Delivery Program ▪ Provide funding for R&I via the successor of S2R
Ensure coordi-nated deploy-ment	▪ Deployment of DAC within the greater framework of all technologies to reflect interdependencies

Requirements for the financing scheme of DAC

- **DAC is a key game changer** in significantly **upgrading the performance of the entire rail sector**:
  - ***Society:*** DAC **enabler for modal shift** due to high impact on the capacity of the system
  - ***Infrastructure managers:*** **avoidance of** substantial **investments** for additional, physical capacity and maintenance of redundant infrastructure installations, e.g., axle counter
  - ***Railway undertakings:*** **more reliable products** (faster, more flexible, more digital) along with operational **efficiency gains**
- **RUs with very limited investment capabilities**, particularly for initiatives with long payback time (time to realization; proportion of direct effects on P&L of RUs to investments required)
- **Substantial public financing required** to achieve a fair balance between benefits and investment capabilities

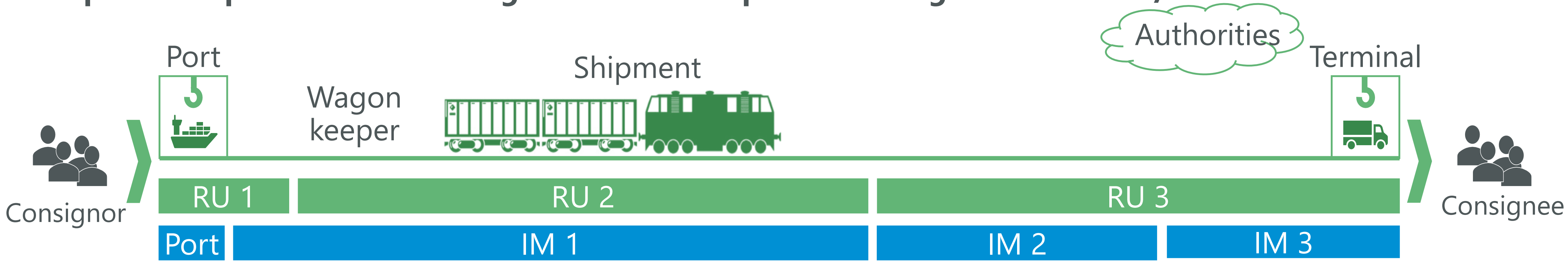
RAILFREIGHT FORWARD
EUROPEAN RAIL FREIGHT VISION 2030

Table of Content

High data availability and quality is an absolute necessity for competitive rail freight transport services

Relevance of data

Complex transport chains with large number of shipments on high number of O/Ds



Customer expectations

- High reliability/adherence to committed delivery time
- High transparency (e.g., location, ETA) and proactive management by RUs
- Competitive cost (high asset utilization)

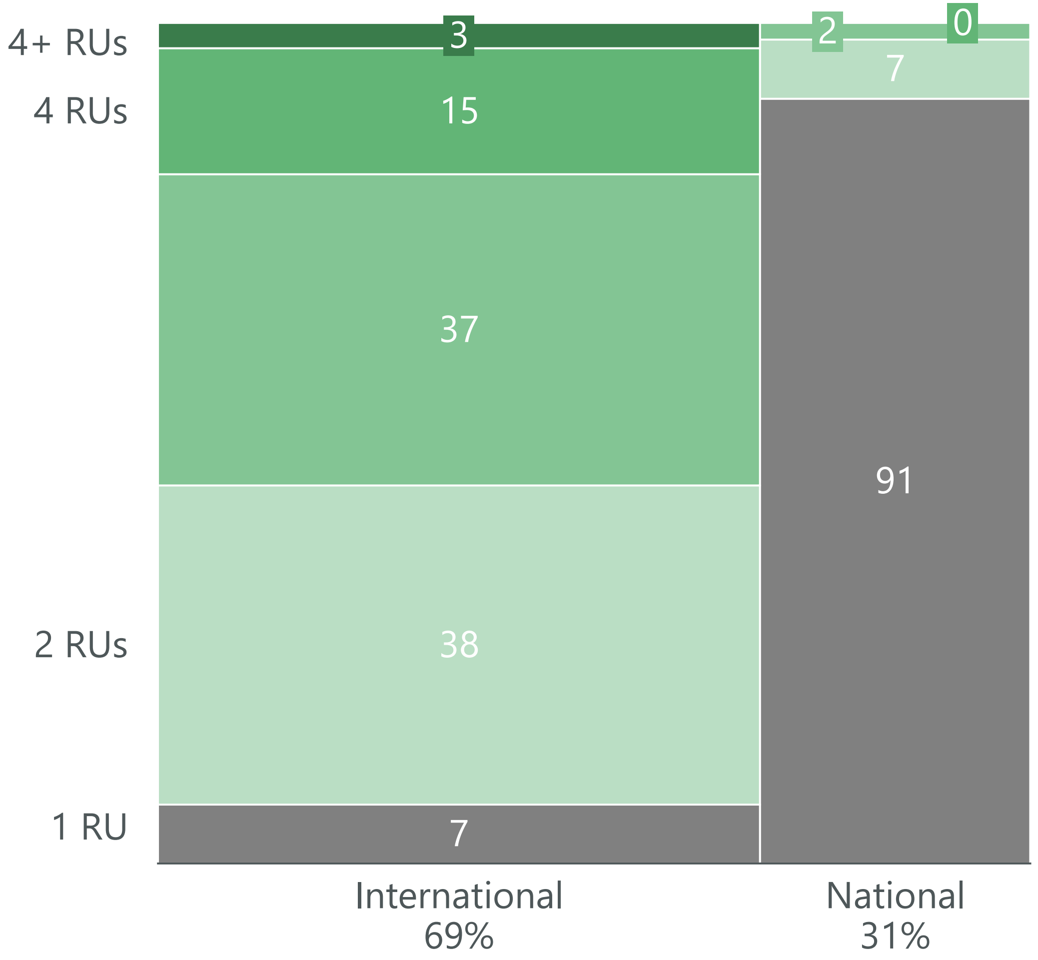
Requirements on data

High **data availability and quality for all players** in the rail freight ecosystem to manage business in a such a way as to meet customer expectations

Most rail freight transports are processed on international level involving at least 2 RUs

DISGUISED RU EXAMPLE

Number of involved RUs in transport chains, in percent by number of transport orders



- Complex transport chains with several involved rail freight players are the norm, not the exception
- Share of international transports expected to grow further

Source: European RU (exemplary)

The current situation results in low data quality and availability – and needs to be changed

Current situation and targeted state

Platform

Current situation			Targeted state	
n = 15	▪ Dominance of individual **bilateral/ multilateral data exchange** ▪ **Low standardization** (≤ 25%) of interfaces ▪ Costly/error prone deployment	›	n = 6	▪ **Seam-/paperless flow of data via platform(s)** between all players based on existing industry standards ▪ **Low cost integration** of small players
	▪ **Fragmentation** with suboptimal role split ▪ **Low effectiveness of** available **platforms**[2]	›		▪ **Clear-cut roles** under **common governance** ▪ **Agile** development methods, focus on value delivery
	▪ **No data-sharing mindset** due to focus on commercial competition ▪ **No** basis to utilize **innovation focus** of 3rd parties	›	1 + 1 = 3	▪ **"Open data policy"** protected by **strong data governance** with build in security ▪ Open for **3rd party innovation**
	▪ **High investment required** for IT and business process adjustments ▪ **No critical mass** of stakeholders to acquire positive ROI on investments yet	›		▪ **Sector-wide commitment** on vision and implementation ▪ **Substantial funding and incentives** for joint implementation by EC

1 And translation services if needed

2 Low innovation, overspecification, waterfall project methods, lack of ownership

Source: VDV

We create a Digital Rail Freight Ecosystem[1] to achieve substantial modal shift to rail

Vision statement Digital Rail Freight Ecosystem 2030

Main levers

- Seam-/paperless flow of data via platform(s) between all players based on existing industry standards
- End-to-end transparency via integration multimodal data (sources)
- Low-cost integration of small players with ready to use services
- Open data policy protected by strong data governance with built-in security
- Clear-cut/integrated provider governance
- Open for 3rd party innovation

Vision

"Together, we create an open Digital Rail Freight Ecosystem that will facilitate **seamless information flows** between **rail freight partners[2] via** common **platforms**, there-by enabling flawless end-to-end transports and efficient freight automation across Europe and beyond

Substantial impact

Flawless end-to-end transportation and automated rail freight

Customer value

Modal shift to rail

Reduction of external costs

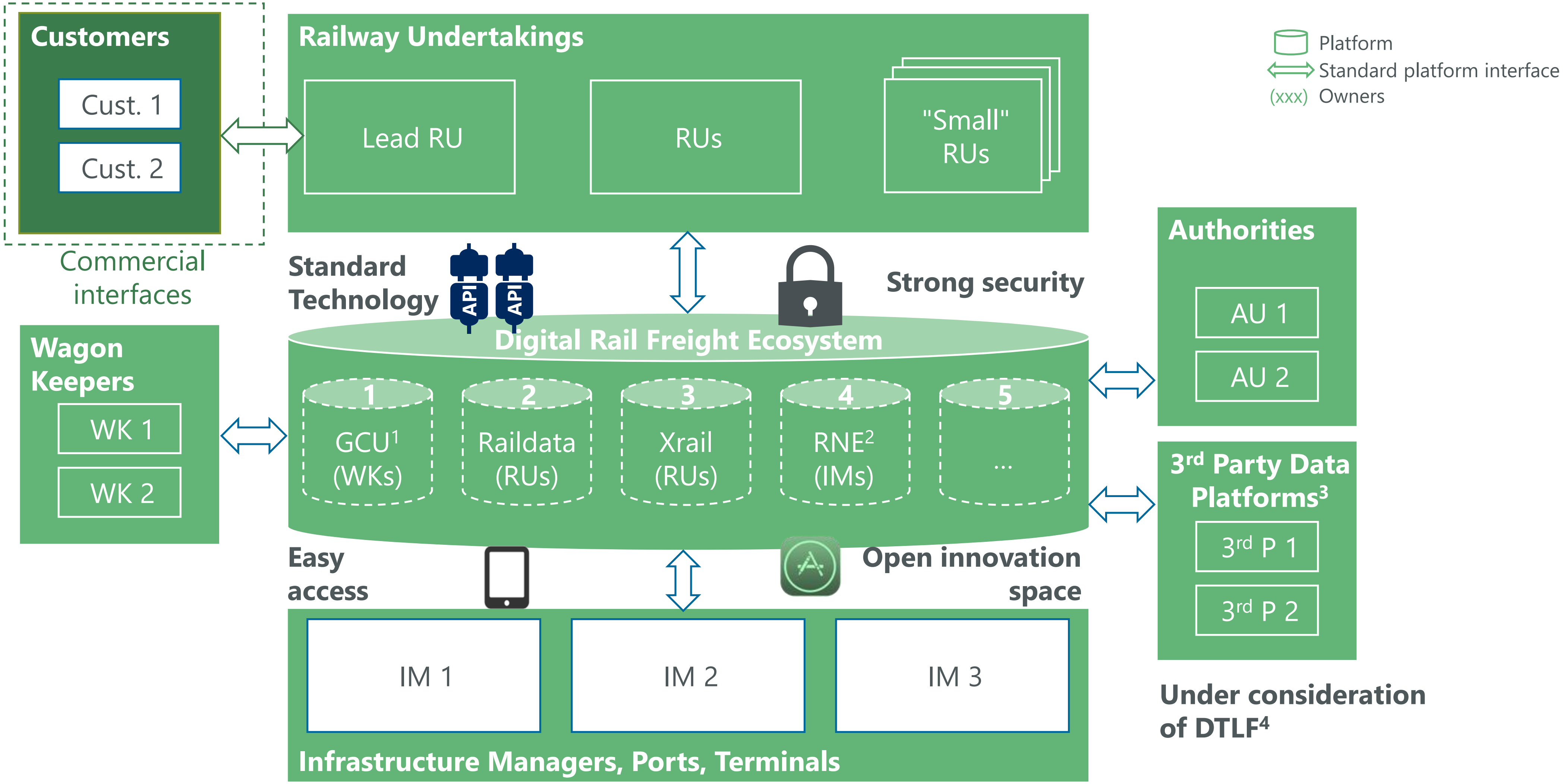
Enhanced environment & mobility

[1] Thereafter also referred to as Digital Ecosystem
[2] Includes other modes in end-to-end transport chains

The Digital Ecosystem will facilitate seam-/paperless information flows between all rail freight partners

Building blocks of the Digital Ecosystem

SCHEMATIC



[1] Broker of the GCU Bureau (General Contract in Use for wagons)
[2] RailNetEurope
[3] Consideration of 3rd parties, e.g., other modes, IoT platforms
[4] Digital Platform and Logistics Forum: framework for electronic freight transport information exchange with authorities

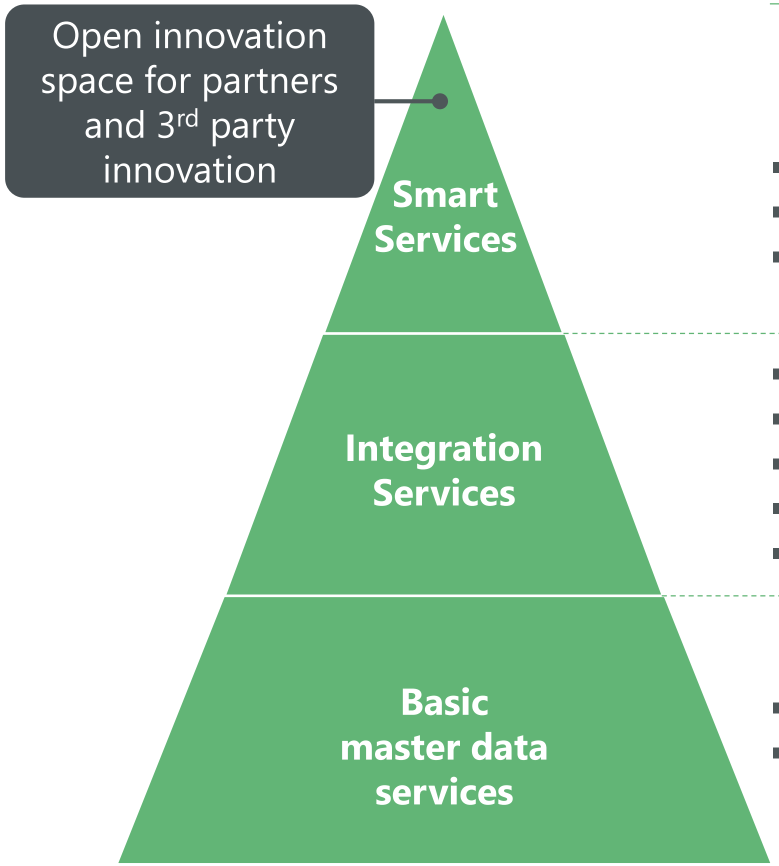
Clear data governance principles are required to enable and support a data sharing mindset

Key data governance principles

Key principles	Description
Openness	▪ In principle, operational data is open for exchange by default ▪ Data objects are categorized in terms of sensitivity ▪ Data owner has the right to exclude data objects from open exchange
Ownership	▪ Data owner remains owner throughout all respective data transactions and processing ▪ Usage of (own) data is transparent and traceable ▪ Data owner has option to opt out on use case basis
Security	▪ Data rights are enforced by security mechanism based on compliance model ▪ Data access rights are clearly defined per role (e.g., for RUs, 3rd parties) allowing external parties access to non-sensitive data only
Easy access	▪ Ensure low burden to access ecosystem and services ▪ Provide one stop shop for small players

The key capabilities of the Digital Ecosystem span basic master data, integration, and smart services

Layers of key capabilities 2030



Purpose of key capability layers

- New services based on/ combining existing services
- Payback on potential upfront investment
- Scale and foster innovation in community

- (Content-based) routing
- Conversion
- Transformation
- Distribution
- Basis for smart services

- Provisioning, management, and exchange of master data
- Basis for integration and smart services

Resolving current limitations increases service quality and provides the basis for smart services

Key capabilities resulting from resolved limitations

Situation

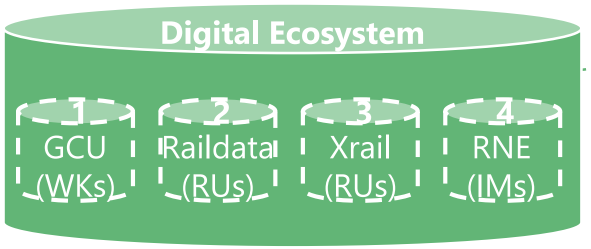
- Numerous service provided on platforms, e.g.,
  - Train service planning
  - Rolling stock data
  - Shipment booking
- Service quality not sufficient, e.g.,
  - Location data quality
  - Missing mapping rules
- Basis for future innovation not provided, e.g., data quality and availability
- Low coverage of small RUs

Approach

- Identification and resolution of limitations in terms of
  - Data quality
  - Data availability
  - Governance
  - Business processes
  - Functionalities

Key capabilities

- Optimization of services by providing, e.g.,
  - Reliable operational data
  - Data quality KPI
  - One stable interface to all players
  - Easy access for small players
- Basis for future innovation and development of smart services



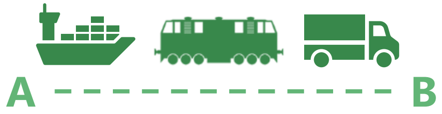
The Digital Ecosystem will provide a framework of accelerated innovation

Prerequisites and potential smart services

Prerequisites

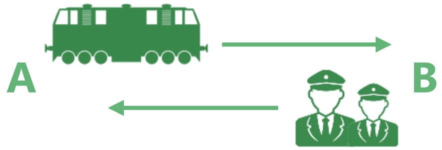
- High data quality and availability by resolving limitations and connecting to 3rd party platforms
- State-of-the-art architecture designed for fast use case implementation
- Open innovation space to utilize 3rd party expertise and use cases (e.g., start-ups)
- Market place for smart services
- Specification governance to foster and protect investments in smart services of different parties (e.g., members, 3rd parties)

Potential smart services



Seamless door-to-door transport planning and execution

Seamless end-to-end track and trace

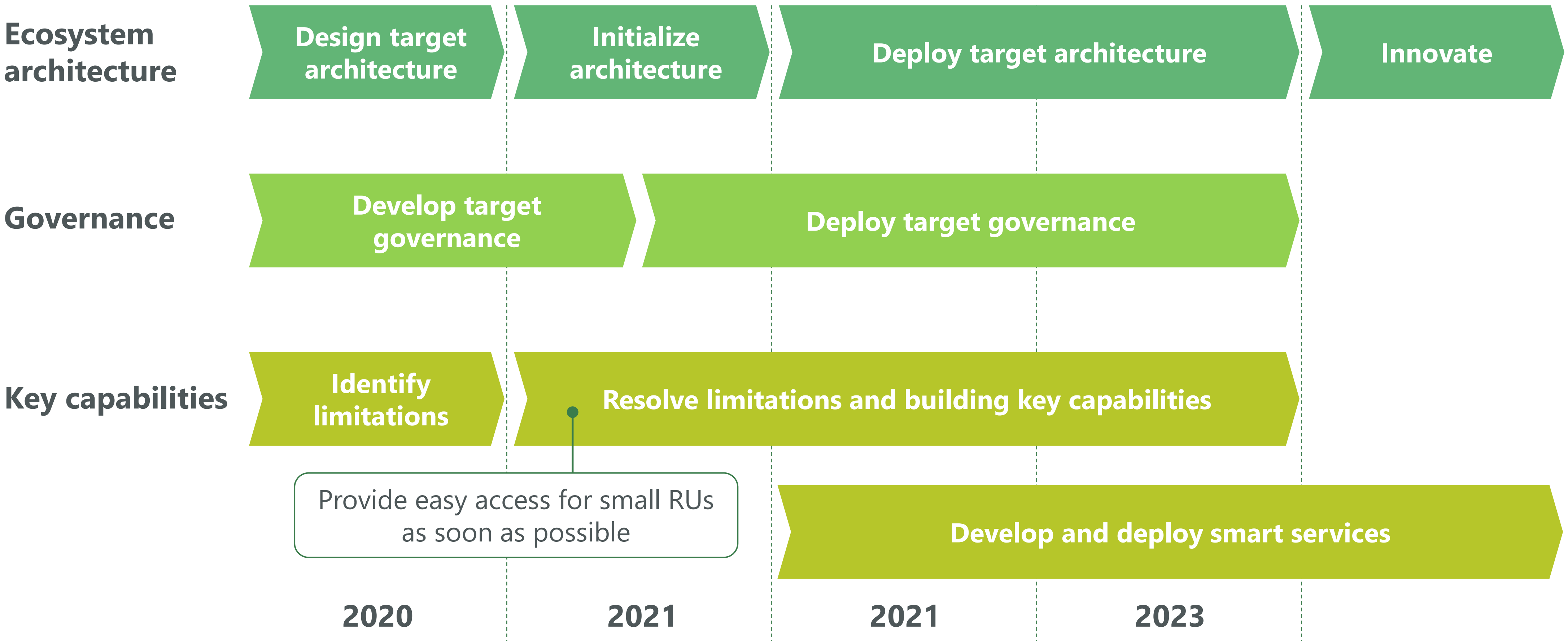


Free capacity sharing (e.g., drivers, assets)

Smart services also act as enablers for other technologies, e.g., telematics

The realization of the vision will follow a step-wise approach

Approach for realization of Digital Ecosystem



The Digital Ecosystem requires ~400 m EUR investment and ~45 m EUR p.a. running cost

Costs of Digital Ecosystem: order of magnitude, in EUR

EXPERT ESTIMATES

Order of magnitude

Considers basic master data and integration services only

- Costs
  - Investment
    - Platform development — **~50 m**
    - RU IT/ process adjustment[1] — **~350 m**
  - Running costs
    - Platform — **~10 m p.a.**
    - RUs[2] — **~35 m p.a.**

Running costs are increasing compared to current situation due to data quality assurance and support of respective processes

[1] Estimate based on 500 small-/medium-sized entities with each 500 k EUR for IT, data quality, and process adjustment and 5 large entities with each 20 m EUR
[2] Based on above mentioned split with small/ medium RUs bearing 50 k EUR p.a. and large RUs 2 m EUR p.a. running cost

It will enable a modal shift to rail with high benefits for customers, society, and the rail freight sector

Mechanism of effects of Digital Ecosystem

Benefits for customers

- More reliable products
- Smart and innovative services
- Better prices through productivity gains on rail

1% cost reduction ≈ 200 m EUR p.a.[1] savings which are (partially) passed on to customer to increase competitiveness

Modal shift to rail

Reduction of external costs for society

Volume growth with optimized cost structure
1% modal shift ≙ 300 m EUR EBIT[2]

Better utilization of infrastructure through higher asset productivity

[1] Based on market volume of 20 bn EUR and average cost structure
[2] Based on 1% additional modal share as of 2030 (~28 bn tkm)

The realization of the Digital Ecosystem requires substantial public funding

Reasons for public financing

- Limited investment capabilities of RUs not sufficient for fast deployment
- Benefits provided for customers, entire rail sector and other transportation modes
- Reduction of external cost for society due to modal shift to rail
- Enabler for other key technologies and associated benefits
- All-inclusive undertaking particularly integrating small RUs and other modes
- European-wide incentive scheme required to ensure participation

Substantial public funding accompanied by incentives for all involved players to successfully implement Digital Ecosystem

Table of Content

RAILFREIGHT FORWARD
EUROPEAN RAIL FREIGHT VISION 2030

The benefit of saving energy is already reaped with GoA2 implementation

Characteristics of different Grades of Automation (GoA)

ATP Automatic Train Protection
ATO Automatic Train Operation

Grade of automation	Train operation	Setting the train in motion	Driving an stopping the train	Opening and closing the doors	Operation in the event of disruptions
1	ATP with a driver	Driver	Driver	Driver	Driver
2	ATP and ATO with a driver	Driver / Automatic	Automatic	Driver	Driver
3	Driverless	Automatic	Automatic	Driver / Attendent	Attendent
4	Unattended	Automatic	Automatic	Automatic	Automatic

- Not relevant for cargo since there are no train attendants

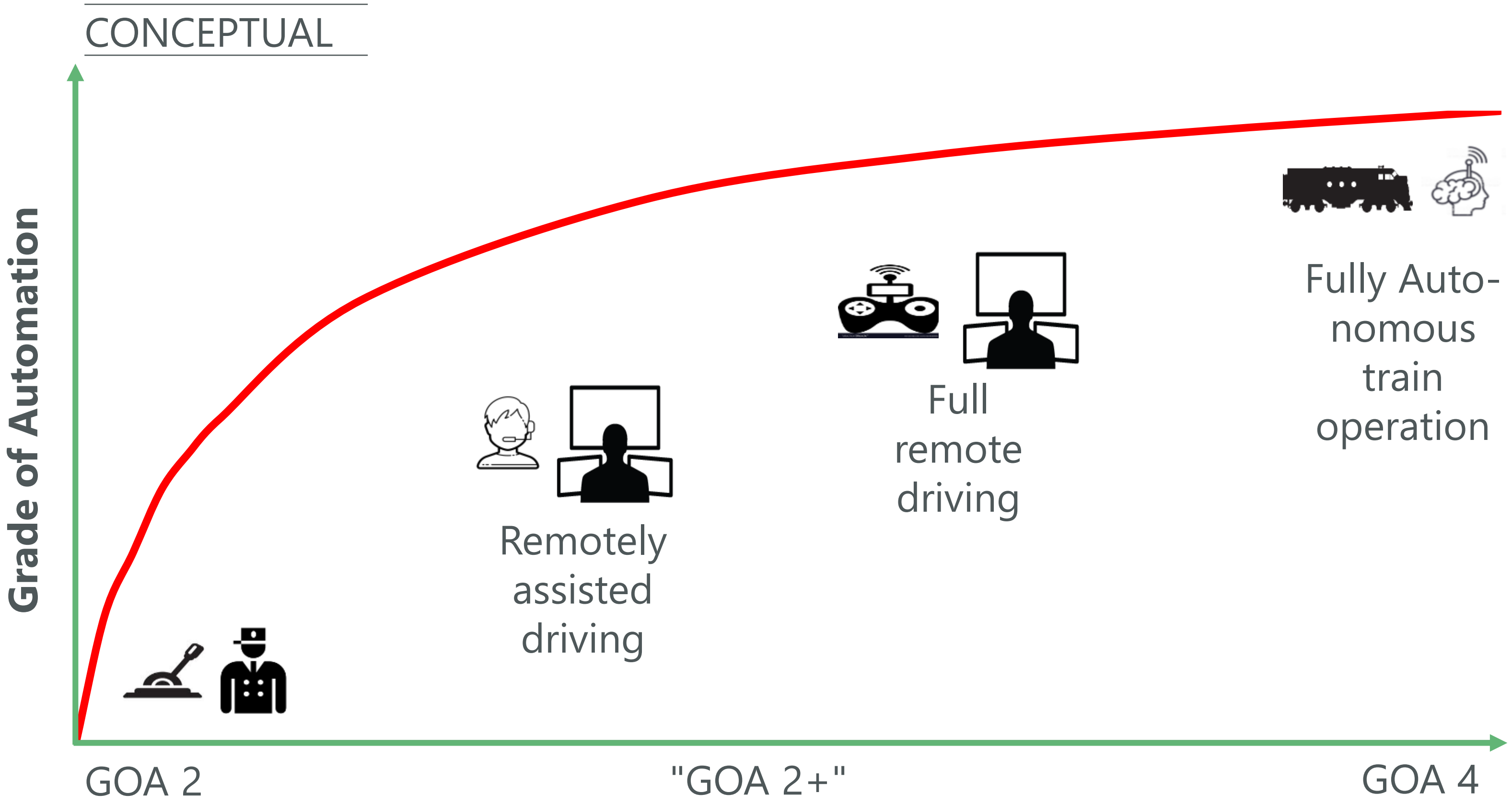
- Innovation takes place be-tween "off-the-shelf" GoA 2 solutions and GoA4
- Additional automation functions beyond GoA 2 simplifies train driving

- Unattended driving, both in long-haul operations as in shunting/last-or-first mile operations
- Locomotive can operate 24/7

Higher energy efficiency and higher capacity (best in combination with moving blocks)

For rail freight, iterative automation steps from GoA 2 to fully automated train operation (GoA 4) are possible

Steps in automation in rail freight long-haul



- In between GoA 2 and GoA 4 there are iterative steps possible to manage the bottleneck resource of train drivers: Remote driving through fully qualified drivers
- For all those options a stable, 100% reliable communication system is mandatory

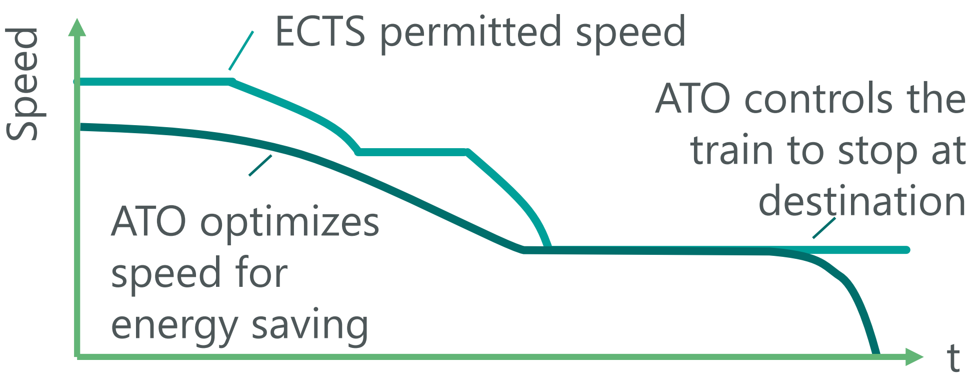
Iterative and cycle-wise ATO migration steps are necessary to speed up the automation process, benefit from short "lessons learnt"-cycles and deliver quick solution for freight with the best quality and performance („low hanging fruits")

RAILFREIGHT FORWARD
EUROPEAN RAIL FREIGHT VISION 2030

Main rail system effects of ATO are on energy and capacity

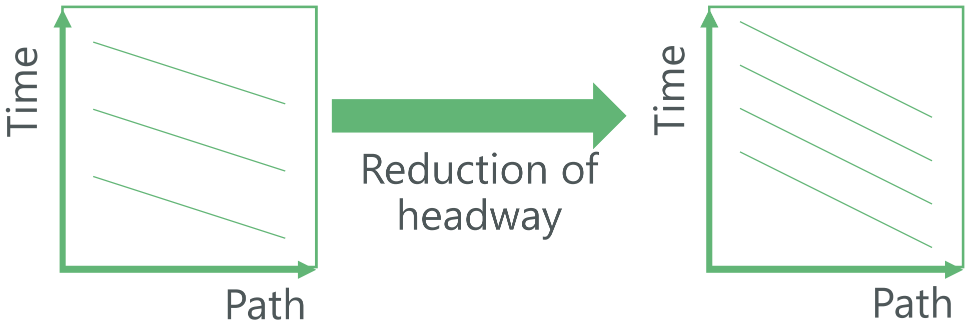
Rail system benefits of ATO

Energy savings effect ~ 10%



- Continuous calculation of optimum speed profile at any time to avoid energy-consuming accelerating/braking
- Additional effects:
  - Less wear & tear of brakes and wheels
  - Less noise
  - Less potential of train ruptures
  - Higher punctuality due to better flow

Capacity effect ~ 10% with moving blocks



- Full capacity effect dependent on additional infrastructure requirements
  - Moving blocks (e.g., ERTMS level 3)
  - Optimized rail paths (DCM) to allow efficient use of ATO

The realistic scenario for full-scale implementation of ATO until 2030 is based on GoA2

Preferred realistic solution

Main characteristics ATO

- Real-time calculation of driving curve
- Exact realization of speed profile "at any time"
  - Full acceleration
  - Cruising
  - Coasting
  - Full braking

Main Effects

	Energy saving	Capacity Increase	Reduction of noise	Improvement Time-table stability/ functionality	Higher efficiency/ flexibility of resources
GoA 2	✓	✓	✓	✓	(✓)
	10% for long-haul for one locomotive	10% in combination with "Moving block", e.g., ERTMS Level 3	More homogeneous driving and less braking	Variations inherent in manual driving eliminated	For GoA 2 simplified train driving
GoA 4	✓	✓	✓	✓	✓
Bene-ficiary	RU/Society ≈ 75 TEUR (locomotive) year*	IM	Society	RU/customers	RU

Grade of Automation (GoA) 4 for long-haul not realistic until 2030

- Long-haul passenger trains will not go for non-attended trains, GoA 4 would be stand-alone for freight
- Technical prerequisites ambitious: In absence of completely fenced-in tracks "Running on sight" with very powerful image processing and Artificial Intelligence systems necessary
- Approval of society not guaranteed (completely unattended trains with length of 700m and up to 1.600t at a speed of 100km/h)
- However, GoA 4 could be used mid-term in shunting yards and fenced-in tracks (Betuwe line, Gotthardt tunnel)

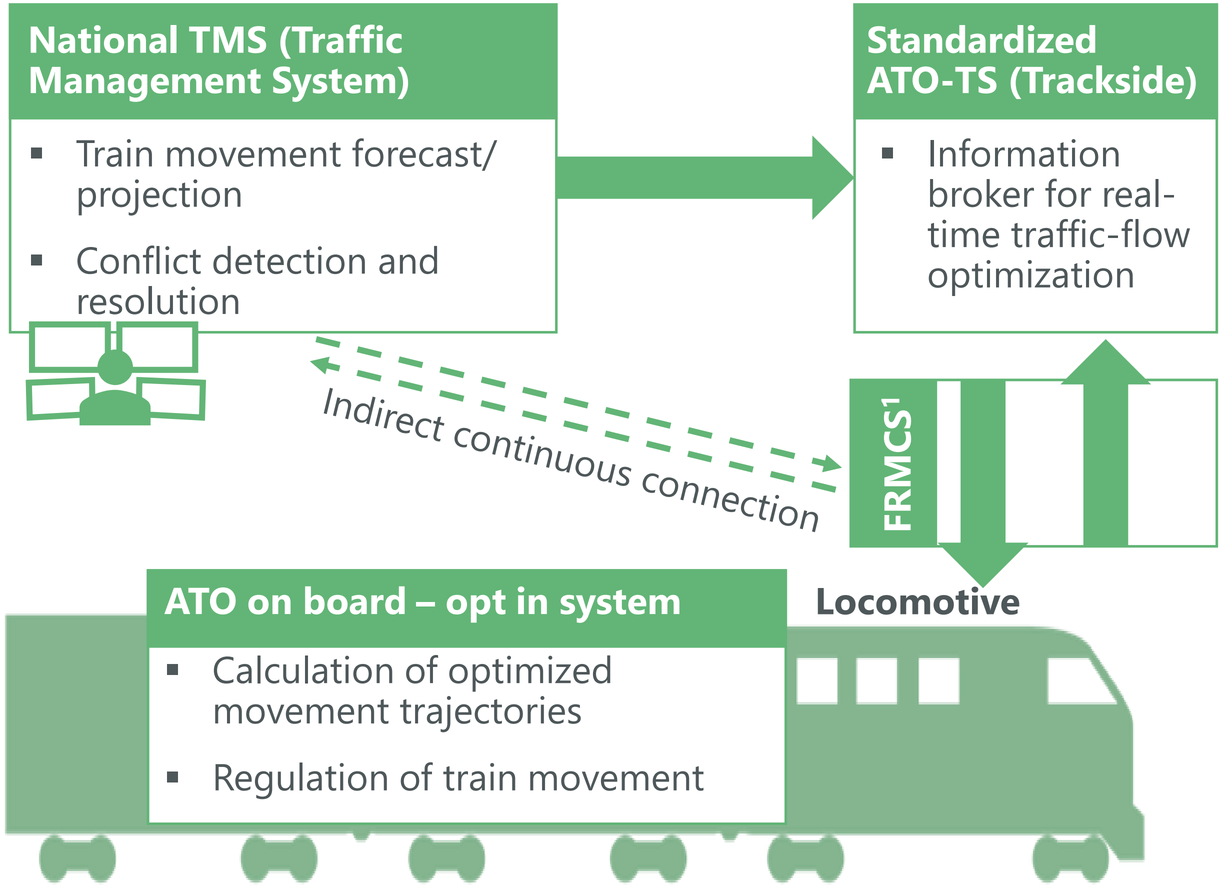
[1] 10% of 5 EUR/km energy costs, 150,000 km per year

Source: Expert interviews, S2R, ÖBB

The introduction of a standardized ATO-Trackside would enable an interoperable ATO at optimized costs

Rough architecture of ATO

ATP Automatic Train Protection
ATO Automatic Train Operation



ATO combined with TMS enabler for

- Collective optimization of several train rides
- "Remote controlling" trains trough qualified, central personnel in case of disruptions

ATO needs to work with any ATP that guarantees "full supervision"

- Heterogeneous and partial network implementation of ERTMS requires an ATO that is independent from infrastructure implementation – underlying ATP requires continuous train protection and supervision
- ATO onboard rolling stock integration and homologation must be fully modular with open specifications to avoid vendor lock-in (example ETCS)
- ATO should be an application with standardized interfaces to one or more ATP ("Automatic Train Protection"), to TMS ("Traffic Management System") and to the driving control, thereby enabling "Plug & Play"
- ATP will remain the master controller of the train, just like with conventional driving

[1] Future Rail Mobile Communication System
Source: Siemens

The vision is to run automated trains on European freight relations

Vision and benefits ATO

Vision

Creating automated rail freight relations by 2030 - starting with freight ATO GoA 2[1] over ERTMS homologation by 2025. ATO onboard system must be able to interact with different ATP systems that provide "full supervision", not only ERTMS, in order to overcome the holes in the ERTMS deployments trackside and allow a widespread introduction of ATO in EU

Benefits

- Mainly for RUs
  - Higher capacity of assets by de-coupling transport offer from availability of bottleneck resource "train driver", thereby driving market growth
  - Energy savings of up to 10% for long-haul depending on type of operations
  - Shorter transit times and higher level of punctuality (up to 10%)
- Mainly for IMs
  - Higher capacity of up to 10% depending on concrete rail path characteristics and installed ATP

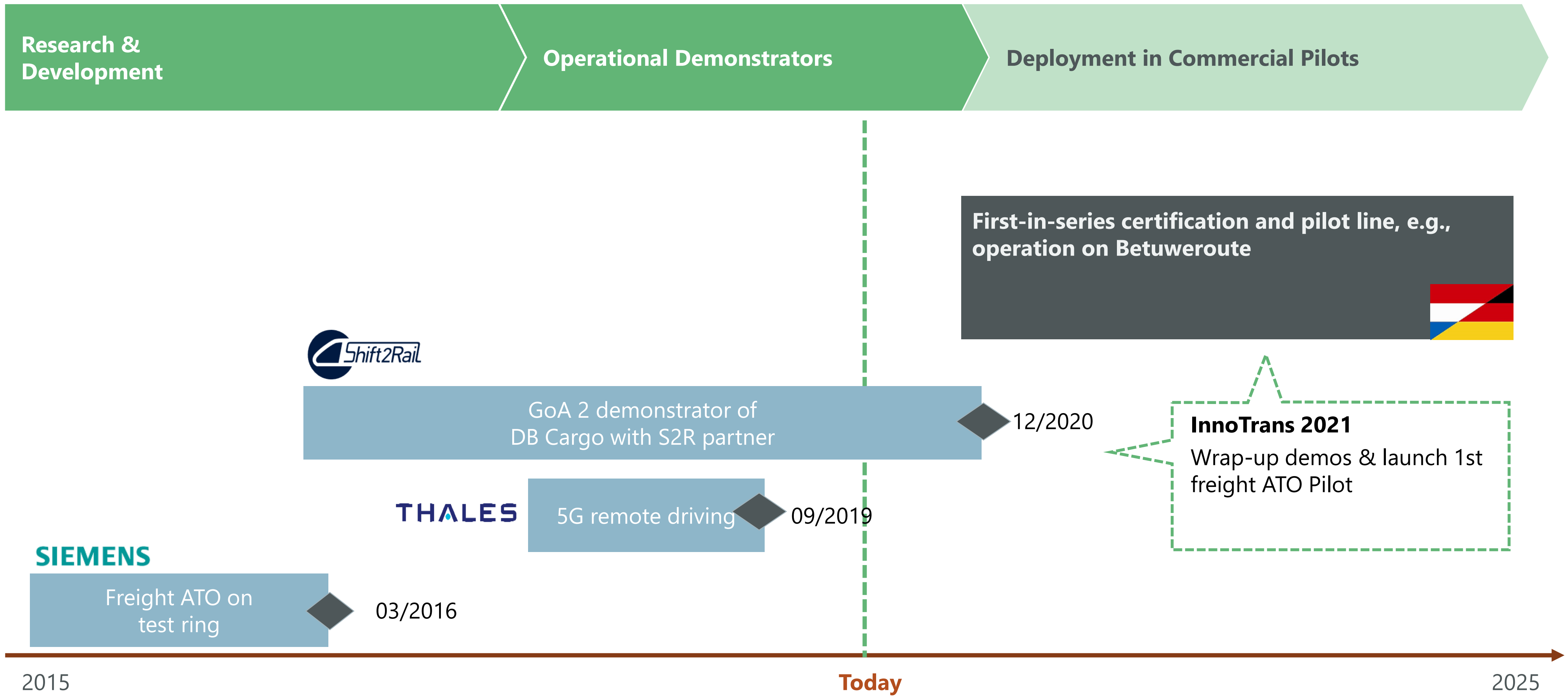
[1] Grade of automation

Source: Shift2Rail, ÖBB, Expert interviews

Freight needs a ATO lighthouse project as a reference to initiate the deployment

Not exhaustive

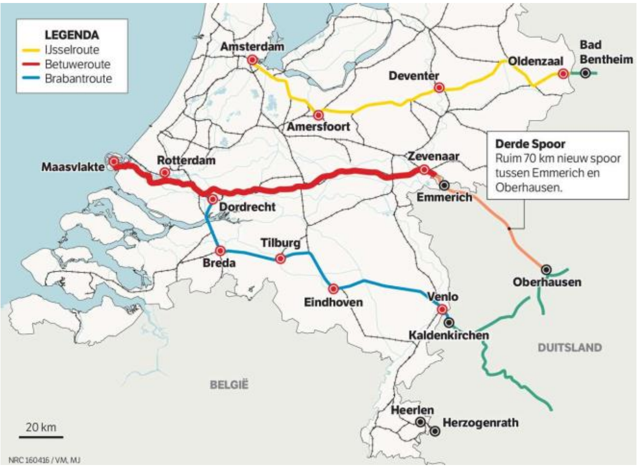
Phases of system deployment ATO



Betuwe would be a possible pilot line for ATO migration in rail freight

Betuweroute is an ideal project pilot line for ATO operation

- Betuwe line is a dedicated freight line on a European growth corridor
- Fenced in track with ETCS L2 is ideal base infrastructure for testing of ATO
- ProRail has vast experience with and expressed interest in ATO pilot line operation
- Rhine-Alpine corridor will continue to be a backbone for mainline transport
- Continuation Emmerich-Oberhausen ideal for continuation under ETCS L2 from 2025
- Political climate DL/NL is ideal under JDOI and Masterplan offering 50% funding



To put ATO into practice for rail freight several action items are recommended

Action items ATO for Green Deal

Continuation of development	▪ Continue development of ATO competencies in "S2R 2" as a core objective in working plan – Open system architecture with standardized interfaces and a referenced test bench for simulation rather than open field test (CCS) – Infrastructure-independent and interoperable GoA 2 short- to midterm (onboard and infrastructure) – R&I for GoA 4, e.g., particularly powerful image processing – Specifications for harmonised ATO-Trackside along with harmonised TMS-processes
Adaption of regulation	▪ Continuous update of regulation in order to foster technological development ▪ Facilitated homologation of solutions (i.e. image processing, artificial intelligence)
Start pilots for "GoA 2+"	▪ Enable first in class certification for freight "GoA2+" pilot lines by 2025 ▪ Enable show-case operational GoA 4 relations prior to 2030, i.e., completely fenced-in track (Betuwe) or tunnels (Gotthardt)
Financial contribution to kick-start GoA 2	▪ (Co-) financing of costly prototype homologation process "GoA 2" in rail freight ▪ Incentives for ATO rollout on key freight relations due to positive impact on capacity and energy savings (external costs of CO_2)

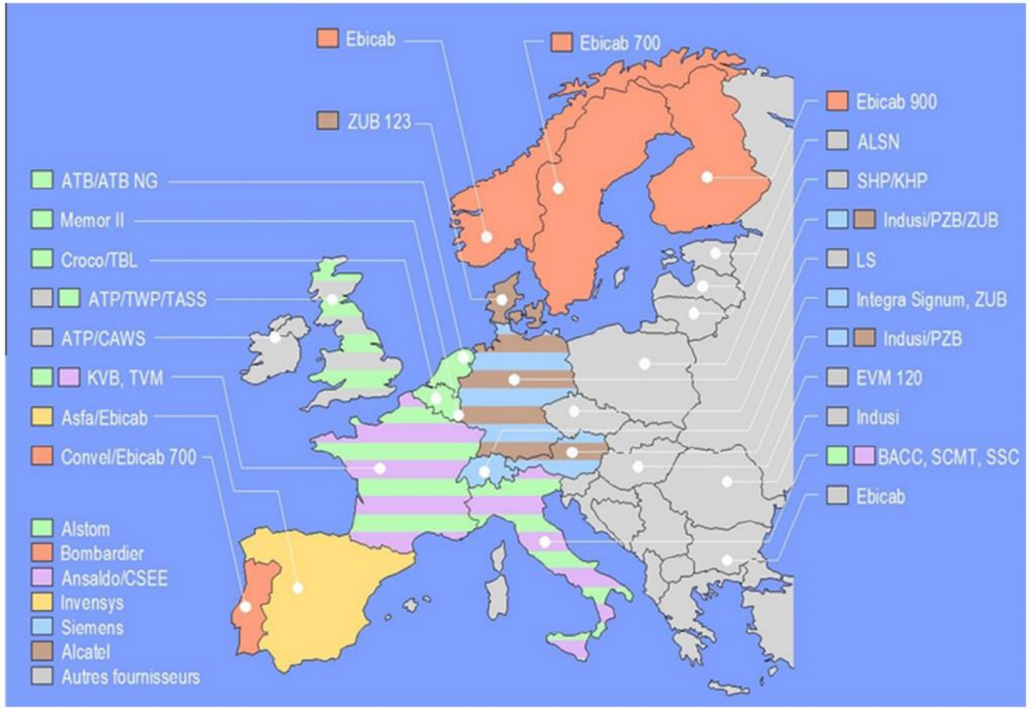
Table of Content

RAILFREIGHT FORWARD
EUROPEAN RAIL FREIGHT VISION 2030

The standardization of ERTMS is key enabler for a more competitive international rail freight offering

Components of ERTMS and impact

From >20 legacy systems…



Competitiveness of rail freight several **hampered** because of **technical barriers** to international journeys (historically **>20 different**, non-compatible **train control systems** in the EU)

…to one European train control system

Two plus one components of ERTMS

ETCS
European Train Control System (Trackside Systems + OBU)

GSM-R (FRMCS[1])
Reserved frequencies for communication

ETML
European Traffic Management Layer

ERTMS
European Railway Train Management System
- Trackside equipment
- OBU Onboard Unit

Technically enabled SERA[2] ("Single European Rail Area") by implementing **one standard ERTMS** both on trackside as well as OBU (Onboard units) including established and working processes (ETML)

[1] Future Railway Mobile Communication System
[2] SERA regarding one ATP (Automatic Train Protection), further technical barriers include voltage and different track gauge
Source: Formalizing a subset of ERTMS/ETCS specifications for verification purposes, Article in "Transportation Research Part C Emerging Technologies (TRANSPORT RES C-EMER)"

Full benefit of ERTMS with level 3

Three Levels of ERTMS

ERTMS

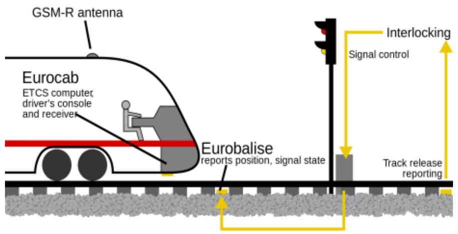
- Train control standard that supervises train movements at all times with significant improvement of safety
- Information received from trackside equipment (balises or radio)
- In-cab equipment (OBU) processes information, calculating maximum speed and breaking the train, if necessary

Downward compatibility

3 different levels of ERTMS

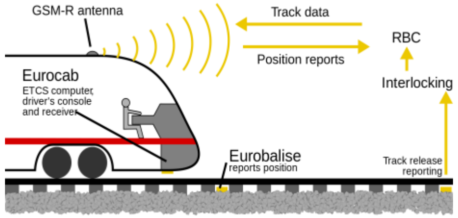
Level 1 (operational)

- Continuous supervision of train movements, non-continuous communication between train and trackside (Eurobalises). Train detection performed by trackside equipment outside of scope ERTMS



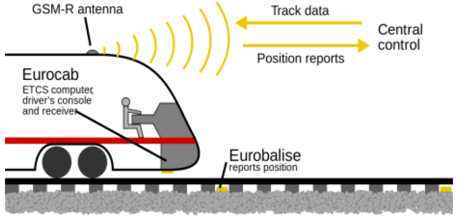
Level 2 (operational)

- Continuous communication provided by GSM-R, lineside signals optional
- Infrastructure trackside functions transferred to OBU



Level 3 (prototypes)

- Train detection (location and integrity) performed within scope of ERTMS; i.e., train integrity supervised by train
- Full infrastructure trackside functions transferred to OBU



Main benefits

Level 1

- Interoperability on ERTMS Level 1 standard

Level 2

- Reduction of maintenance of trackside equipment
- Reduction of length of headways and therefore increased capacity

Level 3

- Significant increase of capacity (~40%) due to moving block
- Fast effect compared to building of new tracks

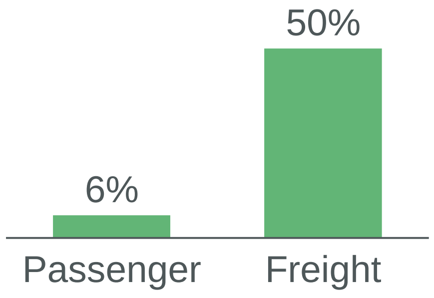
Baseline 2: First set of requirements to be adopted at European Level (interoperability)
Baseline 3: Evolution of baseline 2 with additional functions and backward compatibility to baseline 2

Source: Work Plan 2020 of the European Coordinator for ERTMS

Main international freight relations need to be equipped with one interoperable ERTMS system

Requirements for ERTMS rollout

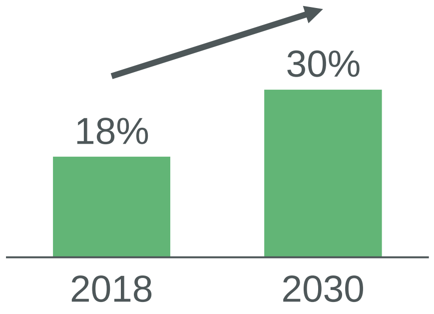
Share of international travel**



Interoperability primarily needed on main international freight relations

- **Main international freight relations should be prioritized**, as interoperability of particular importance to rail freight[1]
- Freight relations **need to include main deviations as well as last mile** (Terminals, shunting yards, …) to ensure one ETCS OBU only
- In order to make interoperability happen, **a financing scheme for OBU has to established**, as RUs cannot finance the migration phase themselves

Modal shift freight until 2030



ERTMS Level 3 needed for full capacity effect

- **Current capacity, particularly on main freight relations**, **not able** to **support the goal of modal shift to 30%** for rail freight
- **Significant capacity increase** of 50%[2] on current infrastructure **only achievable, if ERTMS Level 3 is applied** ("Moving block"), including automated train integrity test

[1] Source: European Commission: "Sixth report on monitoring development of the rail market"; Quote: "Around half of total rail freight is cross-border. This lends rail freight a strong European dimension, and makes it even more sensitive to a lack of interoperability and cooperation between national rail networks that can affect its competitiveness."
[2] Source: S2R Signalling and Communication Research, in combination with ATO

An interoperable ERTMS should be installed by 2030

Vision and benefits of ERTMS for rail freight

Minimum requirement

Installation of an interoperable ERTMS on the **main international freight relations** including last mile (terminals, shunting yards,…) main diversionary routes[1] **and border sections**

Full benefit starting after 2030

- Driver for enabling modal shift of green deal: **Significantly higher capacity** due to reduced headway between trains ("moving blocks") **with ERTMS Level 3**
- Better offering in the market
  - **Lower production cost for IM** due to reduced installation and maintenance costs (full benefit with level 3)
  - **Higher competitiveness of rail freight** due to **interoperability** (level field with road) and **flexibility to allocate resources**
  - **Higher reliability and punctuality** of service (both freight and passenger)
  - **Higher level of safety** than most current Class B

Long-term vision

Installation of **ERTMS Level 3 moving block** with automated train integrity tests on the **main international freight relations** to achieve interoperability and significantly increased capacity

[1] „However, most operators do not operate exclusively on the CNC (Core Network Corridor). A clear example of this are last miles or diversionary routes. A such, ERTMS deployment going beyond Core Network is indispensable" – Work Plan 2020 if the European Coordinator for ERTMS, May 2020

The faster Class B systems are removed, the higher the benefits primarily for the Infrastructure Manager

Key difference between ERTMS and Class B

ERTMS

- Open set of specifications ("platform")
  - ⇨ **Everybody can provide systems**

Class B

- > 20 non compatible systems in Europe
- **Ownership** of specifications/systems **fragmented**
  - ⇨ **Limited competition up to monopoly structures (e.g. in France)**

!

Incomplete coverage of international freight relations with ERTMS perpetuates the existence of Class B systems – the faster Class B systems can be decommissioned, the higher the benefits[1]

- Coexistence of Class B with ERTMS is adding complexity to the IM (need of functional synchronisation) and onboard (functional and mechanical integration)
- Perpetuation of need of Class B OBU resulting in higher costs without change of status quo for RUs
- Limited capacity gains for IMs along with limited reduction of maintenance cost

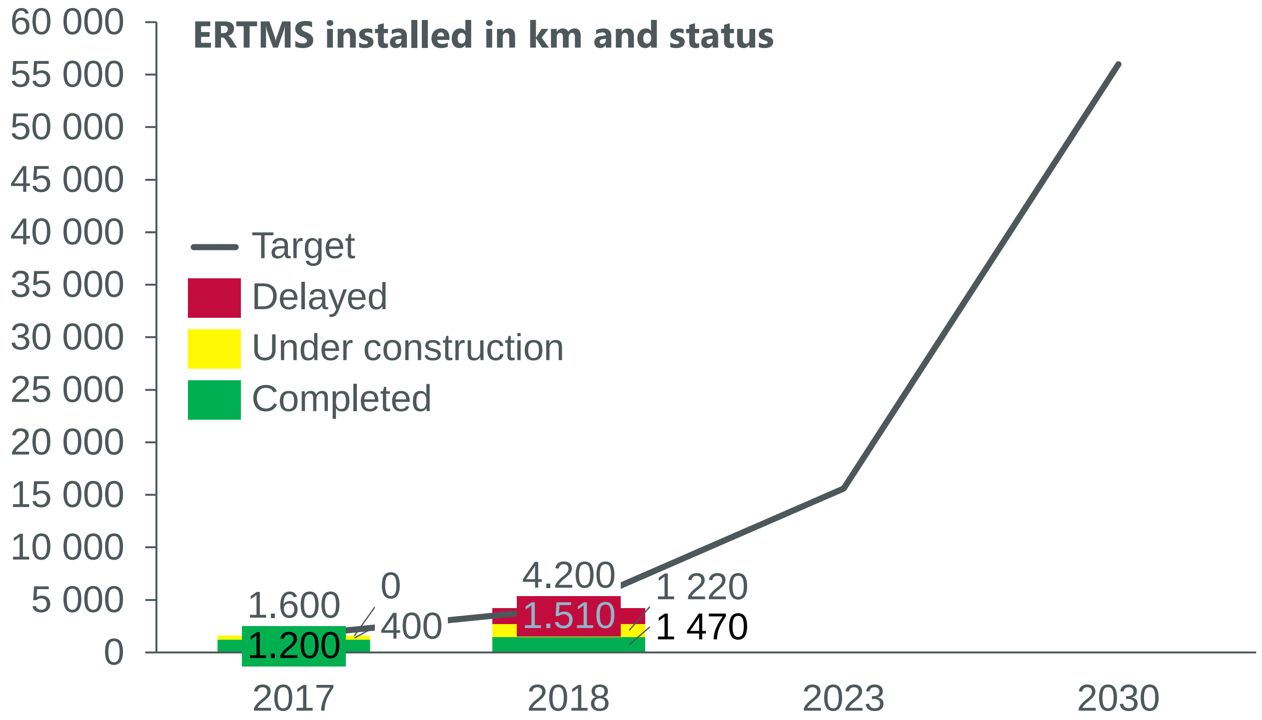
For the transition period make Class B specifications and code public for easier integration into OBU

[1] "We need a deadline for decommissioning Class B systems in Europe – using two systems for decades does not make any sense. It is to some extent an insult to European taxpayers", Matthias Ruete – European ERTMS coordinator

At current level of progress, the deployment targets of ERTMS will not be achieved by 2030

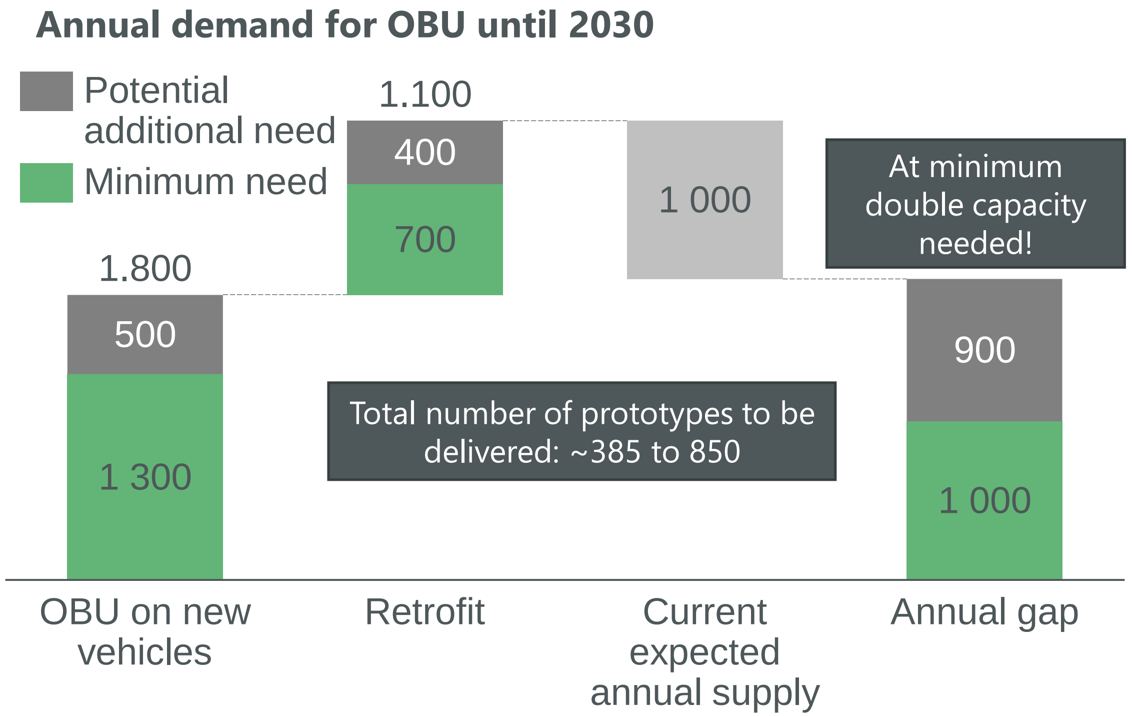
Status of migration to ERTMS

Trackside migration is significantly behind schedule…



- The goal to have ~25% of the European rail network equipped with ERTMS by 2030 seems to be ambitious given the current progress (already in 2018 significantly behind schedule)

… at the same a major industrial initiative is needed to ensure availability of sufficient OBUs



- "Beyond the financing gaps, we may also face an important industrial bottleneck to equip the fleet needed to achieve dual on-board strategy by 2030" – Work Plan 2020 of the European Coordinator for ERTMS

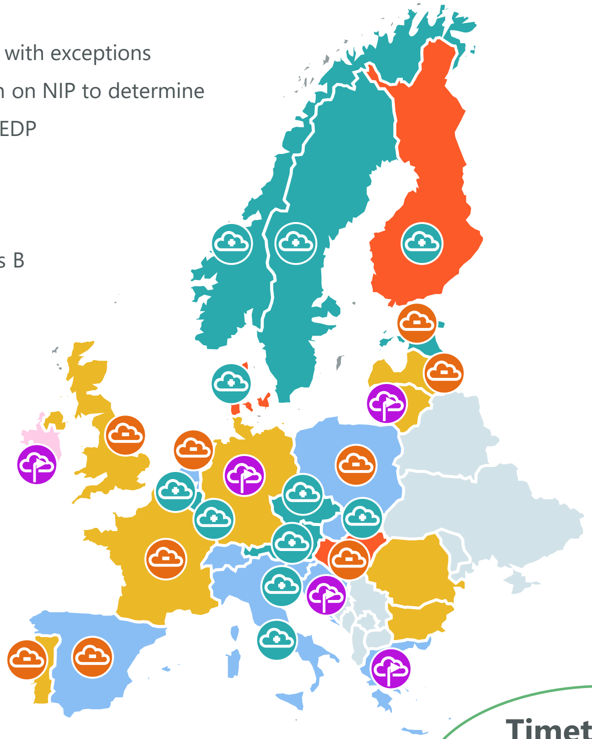
Source: ETCS-another year on, Siemens Mobility GmbH 2019; Work plan 2020 of the European Coordinator for ERTMS

Due to incompatible/divergent rollout plans, the full benefit of ERTMS will not be reaped

National Implementation Plans (NIP) in relation to European Deployment Plan (EDP)

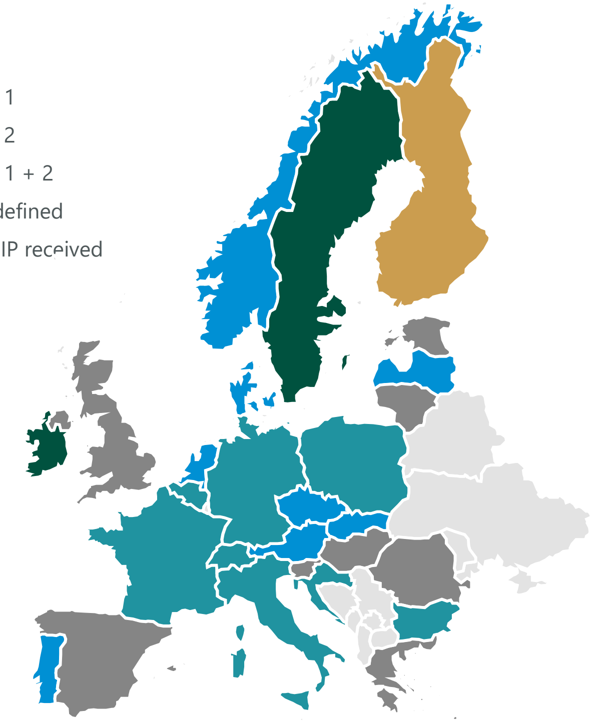
National implementation plans (NIP) plans not compatible with EDP

- NIP compliant with EDP
- NIP compliant with EDP with exceptions
- Not enough information on NIP to determine
- NIP not compliant with EDP
- Exempt
- Plan to remove Class B
- No plan to remove Class B
- No information about removing Class B



Planned level of ERTMS differs between countries

- Level 1
- Level 2
- Level 1 + 2
- Not defined
- No NIP received



Timetable for rollout with significant differences

- The national implementation plans do not reflect the EDP
  - NIPs of larger European countries not fully compliant with EDP
  - No consistent planning to remove Class B systems
  - National additional requirements for ETCS pose a problem for interoperability
- Current international freight corridor implementation not coordinated
- ETCS level 2 will not be fully implemented according to the NIPs by 2030
- Level 3 except for some pilot projects so far no ambition anywhere for 2030

Source: Work plan 2020 of the European Coordinator for ERTMS, Synthesis report on NIP by European Commission, 2.3.2018

Issues that render OBU unattractive for RUs have to be overcome

Obstacles to installation of OBU for freight RUs

High inherent costs per unit

- **Upfront investment of ~0.5 Mio. EUR** (including 1 - 2 Class B NTCs[1], one-off investment per locomotive fleet ~5 Mio. EUR, 0,3 Mio. EUR installation costs per OBU, average locomotive fleet of 25)
- **TCO**: ~0.3 EUR per km higher cost = **+2 - 3%** of current cost per km/locomotive (Total lifetime cost OBU 650.000 EUR for 10 years, ~200.000 km/year operation)
- **Upgrades** with substantial extra costs **partly accounted for in the calculation**

Consequences

- **Financing scheme for OBU needed**
  - Cash constraint: 5x annual cash-flow of one locomotive for OBU
  - Profitability: Rail freight already a 0%-margin business (even negative for some)
- **Cost per OBU to be lowered:**
  - **Decommissioning of Class B systems** to avoid provision of additional NTCs
  - **Permanent updates of TSI to be paid by the originator**
  - Push for **standardization/open interfaces between rolling stock and OBU**

Limited competition due to vendor dominated market

- **Market dominated by a limited number of suppliers and not by customers**
  - High prices due to limited competition leading to high costs of any financing scheme
  - Reduced focus on true customer requirements (customer value)
- **No additional operational value for operators**

Consequences

- **Push for new supplier(s) of OBU** independent from current OEM to
  - Reduce lock-in effects allowing true competition and therefore lower costs
  - Reduce the costs of upgrades and to guarantee compatibility with future baseline upgrades without (or with limited) extra costs
  - Increase the retrofit capacity needed, particularly for older locomotives[2]
- **OBU's with real additional value** by clearly separate safety functions from other functions and allowing add-on's to be build on the OBU (e.g. DAS, ATO, …); OCORA project led by railway sector

No level playing field

- **Different regulation regarding installation of OBU**, i.e.,
  - Belgium: Full deployment of ERTMS OBU obligatory by 2024
  - Luxemburg: ERTMS Level 1 obligatory
  - Germany: No official government plan for full deployment
  - ….

Consequences

- **Uniform European regulation needed**, needs to be combined with financing scheme

[1] National Control System. Legal obligation for member states to make NTCs available not always respected, therefore integration not always possible. ERA without control on national standards of Class B. 2 „Therefore, beyond the financing gaps, we may also face an important industrial bottleneck to equip the fleet needed to achieve the dual-on board strategy by 2030"– Work Plan 2020 if the European Coordinator for ERTMS, May 2020

OBUs are investments in infrastructure and should be paid by the society

Economic impact of OBU on rail sector

Proposed solution

The installation of OBU consumes 5 years of free cash flow of an RU

Economics of typical freight operator (in EUR)

Assumption of "one OBU only" currently not fulfilled

Possible financing model

	Reasoning	Impact
1 By RU	▪ "Ticket to entry": Due to regulation, OBU need at some stage be installed on all locomotives ▪ Main benefit of ERTMS, however, is increased capacity and a technical prerequisite for creation of SERA	▪ Increase of freight rate per km across all RUs ▪ Overall loss of competitiveness for rail freight
2 By IM	▪ Technical creation of SERA clear obligation of IM ▪ IM natural owner of OBU (essential part of managing "capacity of the system")	▪ Same adversary effect on costs per km as 1, unless compensation through 3 by means of higher subsidies
3 Society	▪ Infrastructure in general a public good ▪ OBU are part of the physical infrastructure – investments duty of the society	▪ Investments of EU/national governments to make infrastructure "fit for green deal"[2]

[1] 100 Mio. EUR revenue, 7 Mio. EUR EBITDA with 70 locomotives

[2] "It seems it will be possible for infrastructure managers to design schemes to provide grants or loans to operators for the purpose of supporting onboard ERTMS deployment as a pass-through from member states" – Matthias Ruete, European ERTMS coordinator. "Bridging the financing gap of RUs to equip rail vehicles with ERTMS can be a game changer in pushing forward the whole ETMS program." – Work Plan 2020 if the European Coordinator for ERTMS, May 2020

System needs to be functional for the RU – role in selection of ERTMS OBU system needs to be secured

RAILFREIGHT FORWARD
EUROPEAN RAIL FREIGHT VISION 2030

Key decision makers at EC level are acknowledging the challenges of ERTMS

Quotes from key decision makers at EC level

ERTMS will only demonstrate its full value when it reaches a **critical mass**, when it reduces costs for infrastructure managers and then **for operators it is** a **replacement system** rather than an additional cost

Elisabeth Werner, director of land transport DG Move

We need a deadline for decommissioning Class B systems in Europe – **using two systems** for decades does not make any sense. It is to some extent an **insult to the European tax payer**

Matthias Ruete, European ERTMS coordinator

Operators, especially freight and international passenger, **cannot be left alone with retrofitting**. There is a **need for tangible public intervention**, as the benefits of ERTMS might come many years later while costs are incurred now.

Matthias Ruete, European ERTMS coordinator

The future railway will be digital and automated or it will cease to exist or be pushed to a niche market. **Only via digitalisation** can rail **withstand the competitive pressure** from other transport modes that are evolving much more quickly than rail

Matthias Ruete, European ERTMS coordinator

ERTMS will become the **backbone of railway digitalisation**, which will allow for **introduction of new technologies**, including but not limited to **automatic train operation, satellite positioning** and other technologies capable of **optimising rail performance and capacity**

Work plan 2020 of the European coordinator for ERTMS

Table of Content

SERA requires a harmonized European Digital Capacity Management

Benefits of European Digital Capacity Management

European rail capacity management is a key obstacle to deliver on the target of the green deal …	… and urgently needs an update to become digital

European rail capacity management is a key obstacle to deliver on the target of the green deal …

- **No longer adequate management of capacity…**
  - Dispersed systems and processes for capacity management in Europe
  - 28+ legacy infrastructure management systems in Europe
- **…leading to non-optimum results**
  - Waste of capacity due to not optimized train paths (manual "make to order")
  - Not optimal (cross-border) train paths for freight
  - Long and not synchronised lead times for booking of train paths

… and urgently needs an update to become digital

- Standardized interfaces and processes: Realization of TAF – TSI as scheduled until 2026
- Comprehensive digital representation of infrastructure for SERA

- Higher capacity due to standardized and industrialized train path construction (separation of construction and booking) on a daily basis
- Dedicated and systemized "capacity bands" for rail freight across Europe
- Instant access to harmonized capacity at any time prior to train ride ("one-stop-shopping" in SERA)

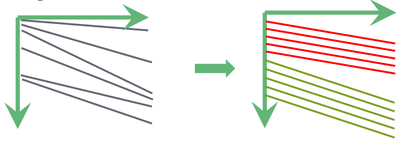
Source: DB Netz AG, SBB

European Digital Capacity Management has a strong impact on the goals of the Green Deal

Levers and Benefits of Digital Capacity Management

Levers

1 Harmonization and bundling of train paths



- **Higher supply of capacity** on current infrastructure: ~+4%

2 Optimization of train paths based on pre-constructed train path snippets

- **Less travel time:** ~ - 6% due to optimized train path

Benefits

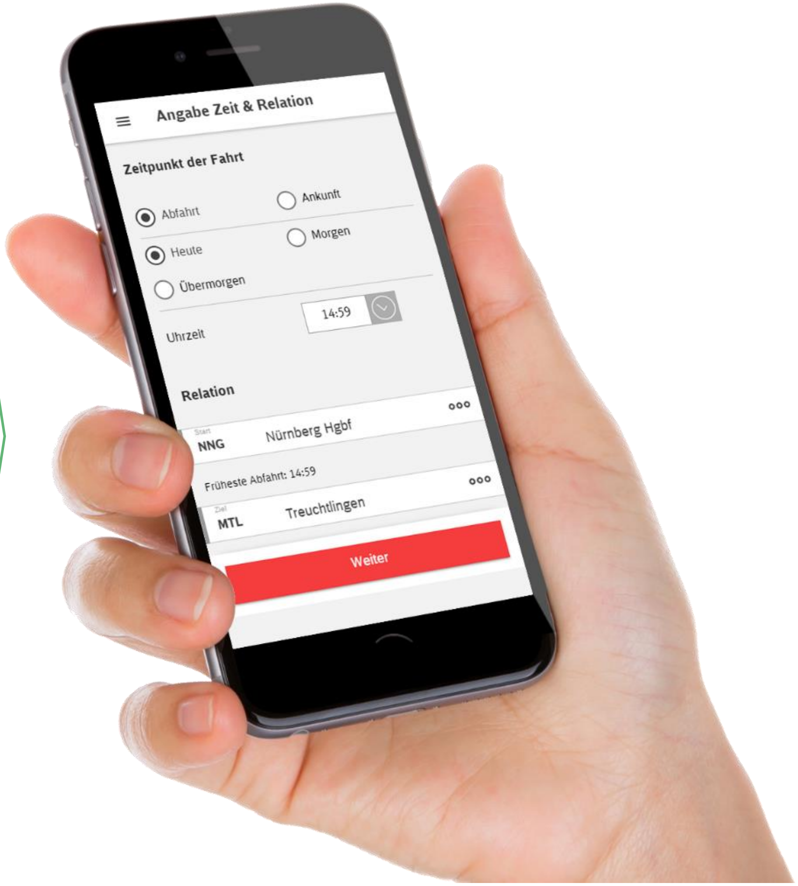
Infrastructure Managers (IM)	Railway Undertakings (RU)
More transparency on available capacity	
Enables implementation of **long-term timetables**, e.g., "Deutschland-Takt" **and TTR (Time Table Redesign)**	
Higher efficiency due to **automatic time tabling** and **train path assignment**	
	15% better utilization of drivers and locomotives due to optimized round trips and reduced synchronization times at borders
	10% energy savings due to less energy – consuming stops for rail freight
	Easy and simple access to optimized train paths across Europe
Automated, standardized interfaces	

RAILFREIGHT FORWARD

Click&Ride – the first innovative product based on DCM has been introduced to the railway market

Example for short-term train path booking at DB Netz

- DB Netz started in 2015 to digitize Time table planning
- First tangible product with Click&Ride launched end of 2019



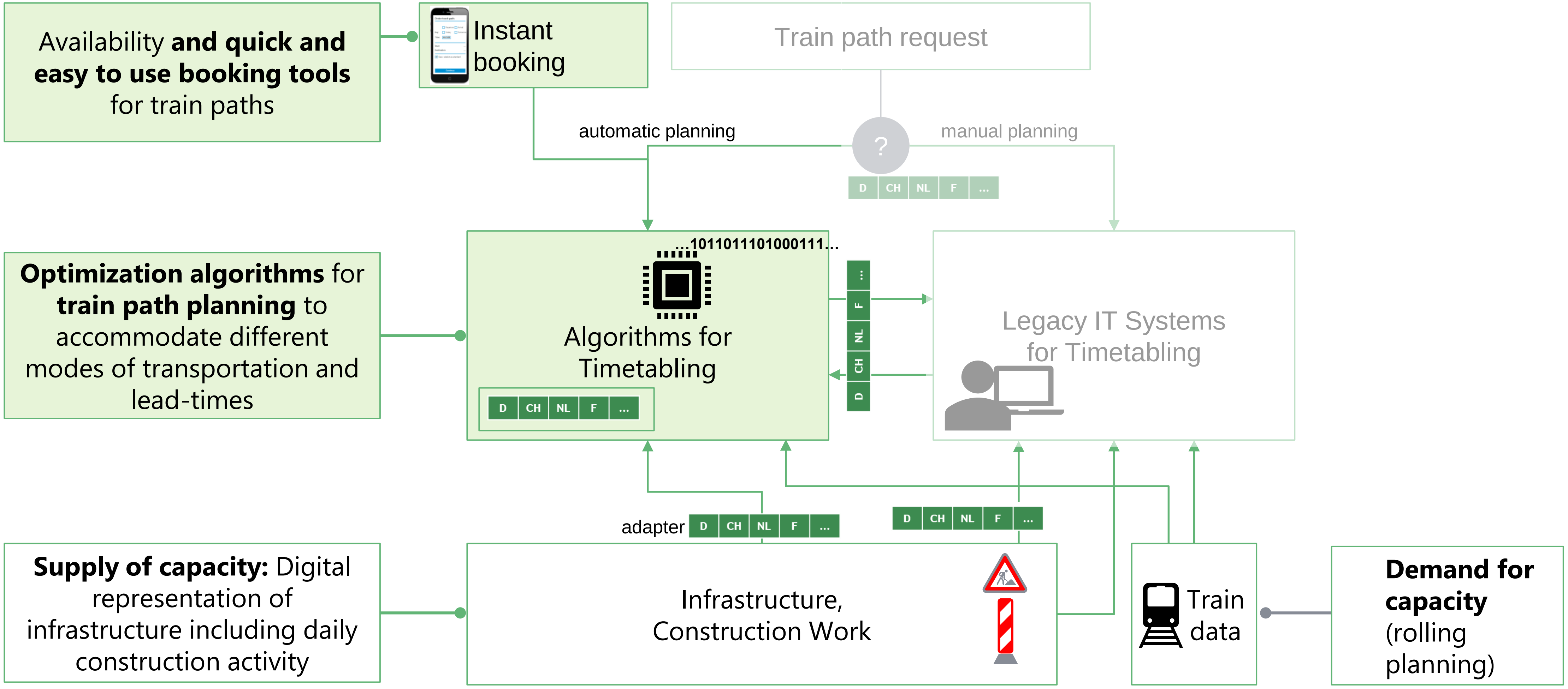
- Planning horizon: min 45 min and max 48 hours before the desired departure of the train
- Train path request with desired departure and / or arrival time is possible
- Train path and timetable within max 3 minutes instead of max. 48 hours by combining pre-constructed train path snippets
- Click&Ride is in full operation since December 17th 2019, more than 800 bookings via the app in the first two months Jan and Feb 2020
- Plan to automatise more than 200.000 path offers in 2020
- Implementation for yearly timetable in pipeline

Source: DB Netz AG

Pan – European access to harmonized capacity needs supporting systems

Reusable from existing DCM projects

Sketch of architecture for Digital Capacity Management



Source: DB Netz AG

DCM shall be developed across Europe in stages - accompanied by first wave of TTR in Central Europe

Proposal for roll-out of DCM

	Phase 1: Staged implementation of DCM	Phase 2: Full implementation in SERA
Timing	~ 2025	2030 latest

Phase 1:

- Introduce DCM in all countries, that are part of the first wave of TTR implementation along corridors (excluding Spain, due to different track gauge)
- Focus on capacity bottlenecks

Phase 2:

- DCM in 28+ countries for comprehensive infrastructure representation
- Algorithmic optimization with focus on countries with capacity bottlenecks

Rollout Phase 1

PROPOSAL

General principles

- Introduce DCM first in countries that the most important freight corridor travel trough (number of train paths, capacity restrictions)
- Apply DCM optimization logic in each country
- Add additional countries for the next important freight corridor until all countries relevant for Phase 1 are connected

Implementation through existing TTR program led by RNE and supported by FTE

- DCM Migration Concept is based on and in line with the existing TTR Concept
- Project is organized by RNE and participation is open for all IMs/ABs
- Those IMs/ABs not participating in the first implementation wave will have the possibility to join at a later stage
- Financial and all other resources necessary for implementation must be made available

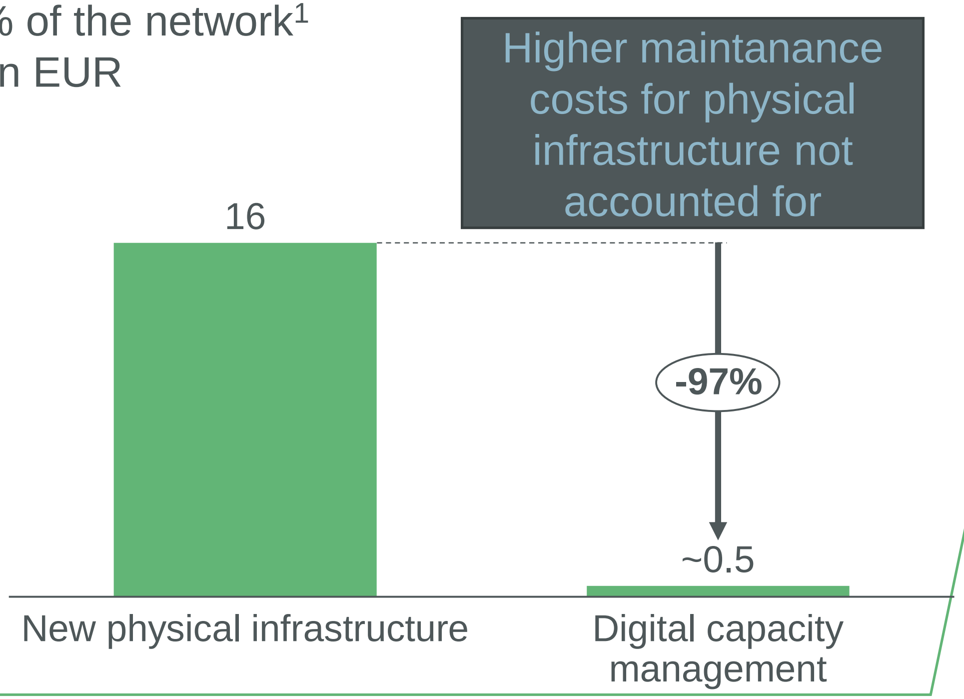
Digital Capacity Management should be treated as investment to be paid by the EC/National Governments

Efficiency of Digital Capacity Management (DCM) – Order of magnitude

ROUGH ESTIMATE

High efficiency of investment in Digital Capacity Management (DCM)

Initial investment for capacity increase of 4% on 50% of the network[1]
in bn EUR



Investment of roughly 500 Mio. EUR[2]

- Cost of connecting all 10 European countries (IMs and Rus) on the main freight corridors to DCM – first validation bottom-up by IMs and RUs
- Funding for upgrading of IT needs to be provisioned for each individual country

Investment with same effect as actual investment in new physical capacity

- Implementation of DCM with significantly lower lead-time than investment in new tracks
- With current financing model, IMs with little incentive to provide pan-European Digital Capacity Management
- Digital Capacity Management in Germany was funded by the government and therefore treated as investment in physical infrastructure

[1] Current European Railway net: 270,000 km, cost for additional capacity: 3 Mio. EUR/km
[2] The study "TTR migration concept and IT landscape" refers to 675 Mio. EUR, including costs for countries, which are not part of the first wave

Prepared by Oaktree Management Consultants
Coordinated by UIC Freight Department