Suppliers view on implementation of ETCS L3 and ATO

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Agenda

- ETCS Level 3 / Hybrid Level 3
- ATO (over ETCS)
- Summary

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- **ETCS L3 / Hybrid L3**

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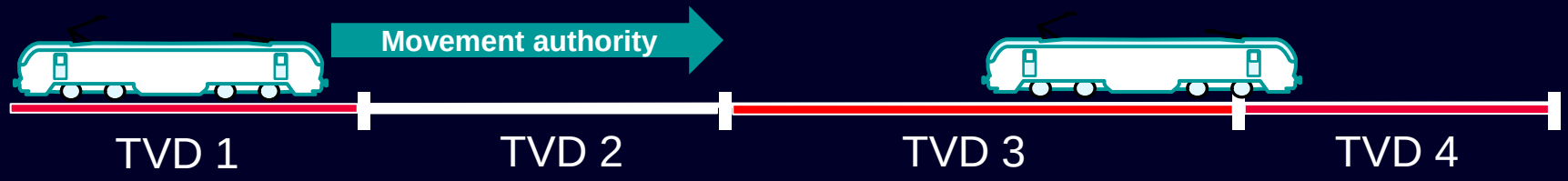
ETCS Level 3: What is the original concept?

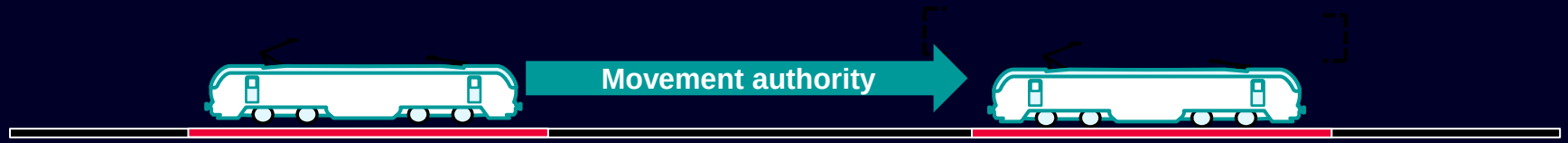
- The “classical” view of “Level 3” has involved trains operating in moving block on a track that has no track vacancy track detection (TVD) and no signal aspects
- Rather than rely on fix-block TVD equipment, trains would instead be located **only** via their position reports to the RBC and operating in moving block
- Train integrity monitoring would ensure that the train remains complete, and the position can be fully trusted.

Conventional



- Remove track vacancy detection equipment
- Moving block operation

Level 3



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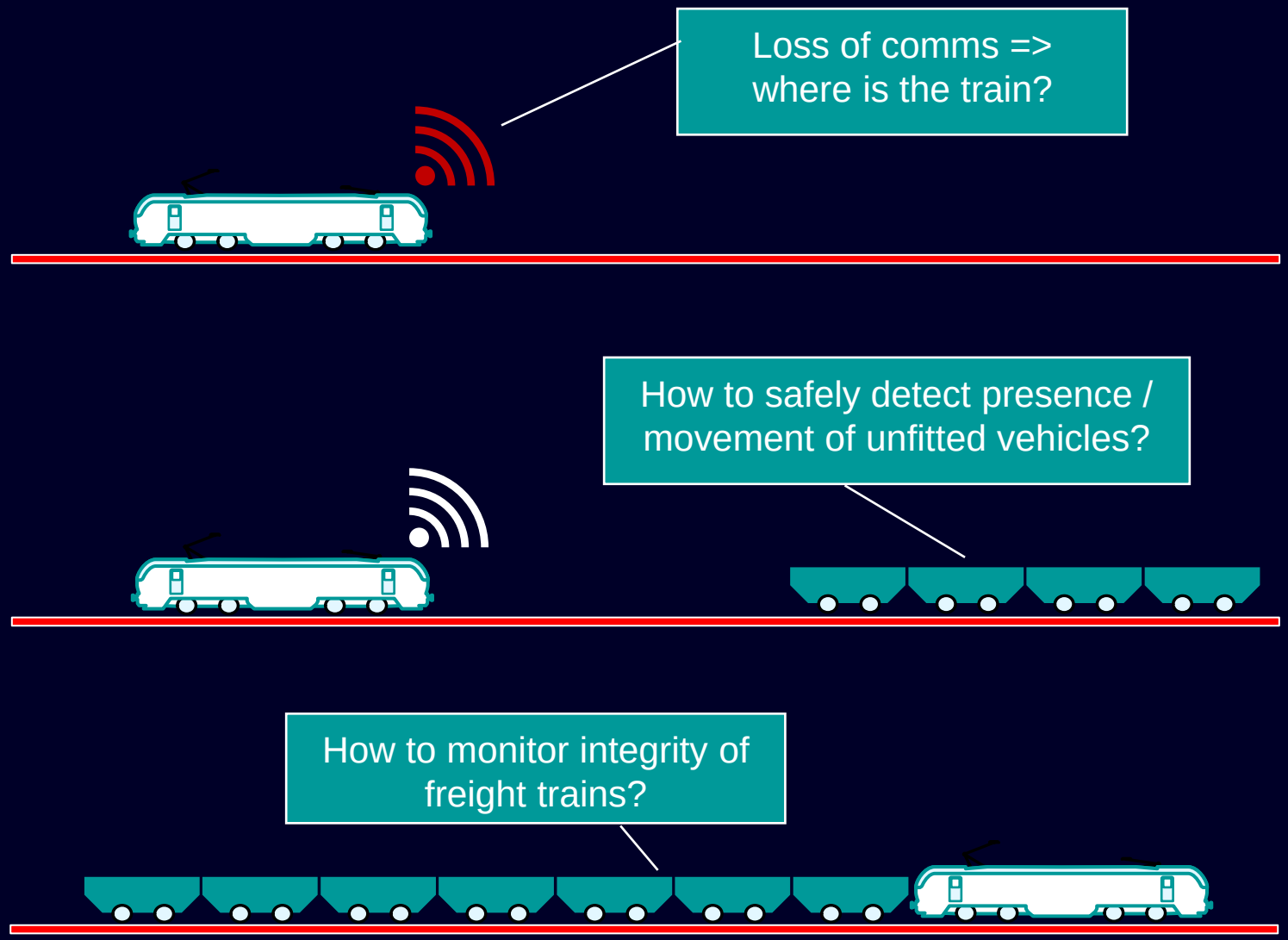
ETCS Level 3 and its challenges

This “Level 3” vision poses several challenges, particularly for mainline railways. Some examples (not exhaustive):

- If there is no TVD, then a loss of communication with the train means that the only source of safe train location information is lost.
- The movement of unfitted vehicles/wagons cannot be detected.
- **All** trains, including freight trains, must be able to monitor the train integrity. Legacy train / mixed traffic not possible



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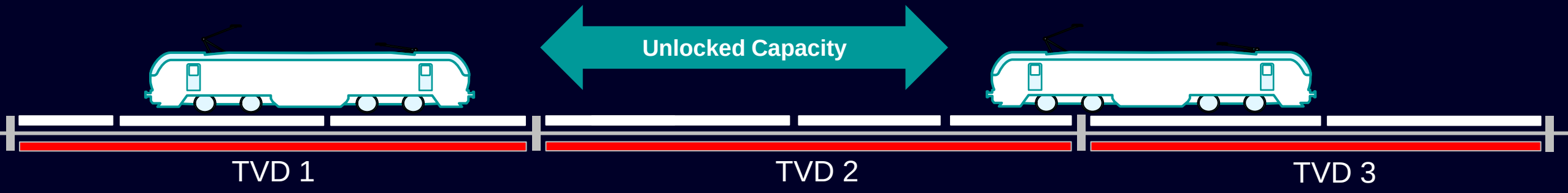
ETCS L3 Hybrid as a path towards ETCS L3 which can be realized short-term and foster the benefits of ETCS L3

- Hybrid Level 3 overcomes these challenges by retaining limited TVD equipment.
  - Even after loss of comms, train movements can still be tracked via TVD.
  - The presence of ETCS-unfitted trains/vehicles can be detected via TVD.
  - ETCS fitted trains that are unable to report their integrity can still run on the line however by reducing overall throughput.
- Physical TVD sections can be subdivided in several virtual subsections (VSS), unlocking additional capacity for ETCS fitted trains.
- The trackside determines the occupancy state of each virtual subsection by safely combining the position reports, train integrity and safe train length from the ETCS onboard equipment with the information coming from the TVD equipment.



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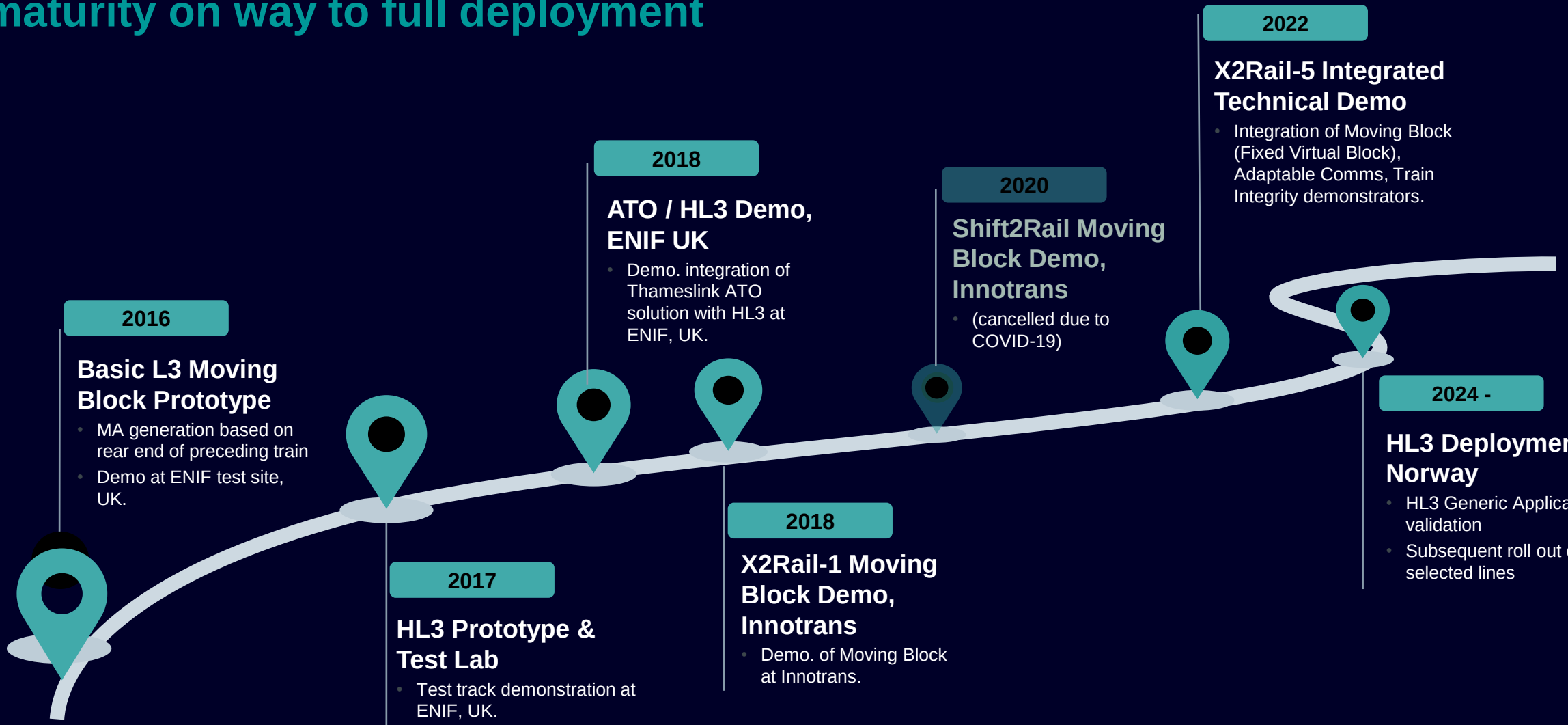
ETCS L3 (Moving Block) / Hybrid L3 (HL3): increasing technical maturity on way to full deployment



2016

Basic L3 Moving Block Prototype

- MA generation based on rear end of preceding train
- Demo at ENIF test site, UK.

2017

HL3 Prototype & Test Lab

- Test track demonstration at ENIF, UK.
- Test lab verification of HL3 Principles

2018

ATO / HL3 Demo, ENIF UK

- Demo. integration of Thameslink ATO solution with HL3 at ENIF, UK.

2018

X2Rail-1 Moving Block Demo, Innotrans

- Demo. of Moving Block at Innotrans.

2020

Shift2Rail Moving Block Demo, Innotrans

- (cancelled due to COVID-19)

2022

X2Rail-5 Integrated Technical Demo

- Integration of Moving Block (Fixed Virtual Block), Adaptable Comms, Train Integrity demonstrators.

2024 -

HL3 Deployment, Norway

- HL3 Generic Application lab validation
- Subsequent roll out on selected lines

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ETCS Level 3 / Hybrid L3: Benefits and Challenges

Key benefits for ETCS L3 Hybrid

- HL3 unlocks additional capacity by subdividing TVD sections into multiple virtual subsections
- HL3 enables operation of trains that are not able to monitor the train integrity (e.g. freight trains, mixed traffic in principle possible)
- HL3 allows reduction of lineside TVD equipment whilst maintaining - or increasing - line capacity, increasing availability and reducing cost by reduction of hardware
- Retention of (some) TVD equipment facilitates degraded mode operation
- HL3's fixed block approach simplifies integration with legacy subsystems/applications that are not yet ready to support moving block (e.g. legacy Traffic Management Systems)

Challenges for ETCS Level 3/ Hybrid L3:

- Need for further standardization of operational and trackside behavior beyond TSI 2022.
- ERJU targeting to align various Level 3 related industry programmes (e.g. Shift2Rail Moving Block, Hybrid Level 3, RCA…) and early involvement of ETCS system authority (ERA) is necessary.
- Safety targets need to be properly aligned and specified
- (e.g. for on-board SIL2 safety target for train length information contradicts assumptions made in industry research programmes).

=> Goal for ERJU is to ensure the full alignment and a common vision for the future.

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- **ATO over ETCS**

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ATO over ETCS brings additional key benefits for railway operation

European Green Deal means:

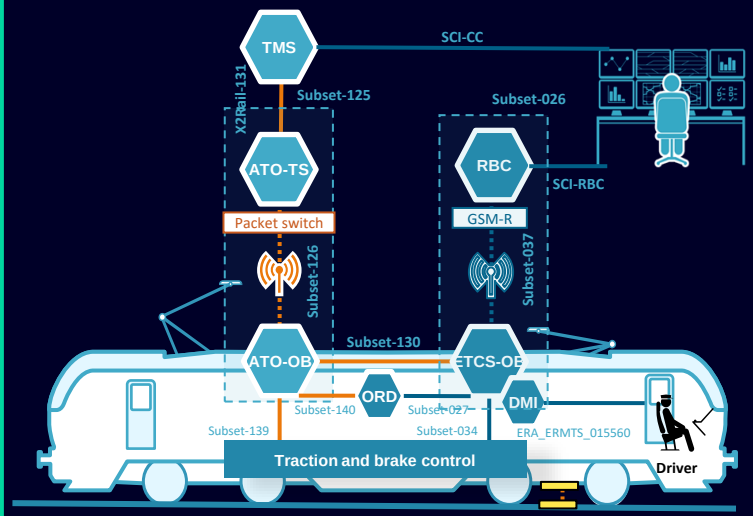
- 55% reduction in transport emissions by 2030:
  - doubling of HS rail traffic
  - automated mobility at large scale
- 90% reduction in transport emissions by 2050:
  - tripling of HS rail traffic
  - doubling of rail freight traffic.

Operator needs:

- demands to further increase capacity
- increase punctuality
- reduce energy consumption for CO2 reduction
- reducing the invest and live cycle cost for railway operation

The solution

- ATO over ETCS according to European standards (TSI CCS 2022)



ATO over ETCS key benefits:

- Improved **network operation performance**
- Enhanced **transport capacity**
- Increased **stopping accuracy**
- Improved **timetable stability** and **punctuality**
- **Energy savings**
- **Reduced mechanical wear and tear**
- **Increased passenger comfort**
- **Optimized boarding and passenger management**

Market development

2021 - 2022	2022 - 2025	2025 - 2030
Piloting for roll out programmes with focus on customers with dedicated fleet/own network market	Realization of to **large scale roll out projects**	Extend to whole **national networks** including **cross border traffic**
e.g. digital S-Bahn Hamburg	traffic nodes / high density lines e.g. digital node Stuttgart	national networks, international corridors

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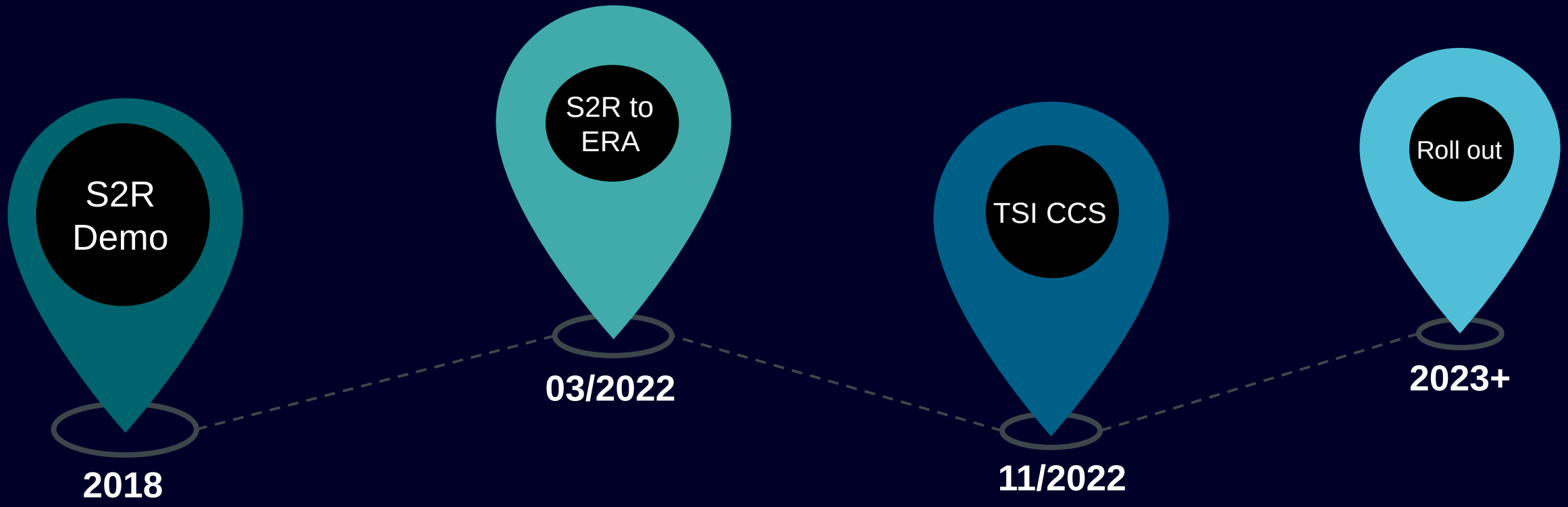
ATO over ETCS – Status of Standardization and Implementation



Align and support standardization

- Stable intermediate draft release for technical S2R lab tests and field demonstrators

Completion standardization

- Update of ATO over ETCS specifications based on S2R lab, field experience and input from pilot projects

Introduction standardization

- ATO over ETCS specification in TSI CCS 2022
- Start of further commercial projects

Roll out and updates

- Tenders including ATO
- Further user topics implementation

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ATO over ETCS strategy considers the interests of the majority of stakeholders

- Many **stakeholders** are in in the growing ATO Mainline market with **different requirements and interests**
- Challenge to develop a **harmonized roadmap for the ATO over ETCS rollout**
- Improve **aligment** within **national and European programmes**

Interest of main stakeholder

Network provider

- **Increase revenue (€ per Train km) due to higher network utilization (increased capacity especially in high-dense areas) due to shorter headways**
- Lower maintenance costs for track work due to reduced traction/braking
- Less peaks in the rail electrification network
- **Less investments in new lines**

Operators / Main line Passengers (S-Bahn, Regio, HS)

- **Increase quality of service (e.g. punctuality, shorter stops at stations)**
- **Increase capacity and flexibility**
- Less energy consumption
- Less operational disturbances (smoother operation)
- Improved recovery from disruption

Operators / Main line Cargo

- **Personnel availability / especially high skilled train driver (personal costs)**
- **Higher personnel efficiency (knowledge of the route, breaks)**
- **Less energy consumption**
- Less operational disturbances (avoid unnecessary stops)
- Capacity / throughput
- Less maintenance (wear)

Operators / Yards

- **Reduction of personnel costs / personnel efficiency**
- **Productivity**
- Increase of safety

Vehicle supplier

- Offer more efficient vehicles (competitiveness)

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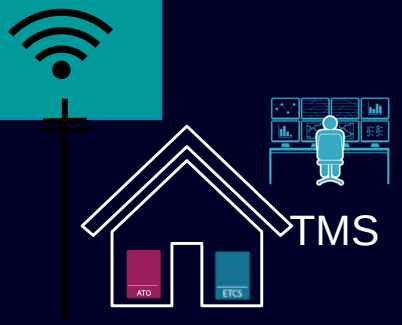
ATO over ETCS – combining time table dispatching and ATO journey profile

ATO unleashes is full benefits by interfacing to a traffic management system

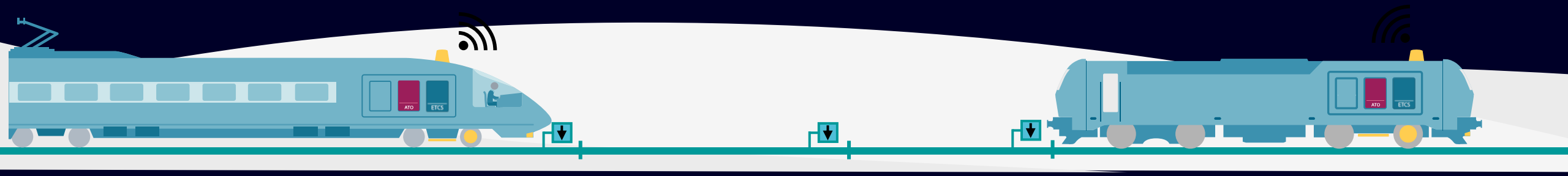
Optimizing traffic flow network-wide for maximum possible throughput with **high timetable stability** by getting the time table an journey profile from an ATO-TMS landside and

Reducing energy consumption and mechanical wear and tear related to vehicles and track by automatically optimizing train driving.



→ **Cooperation and standard interfaces** between vehicle operators and network operators is key for ATO integrated solution

→ Evolution strategy with **migration steps** is possible



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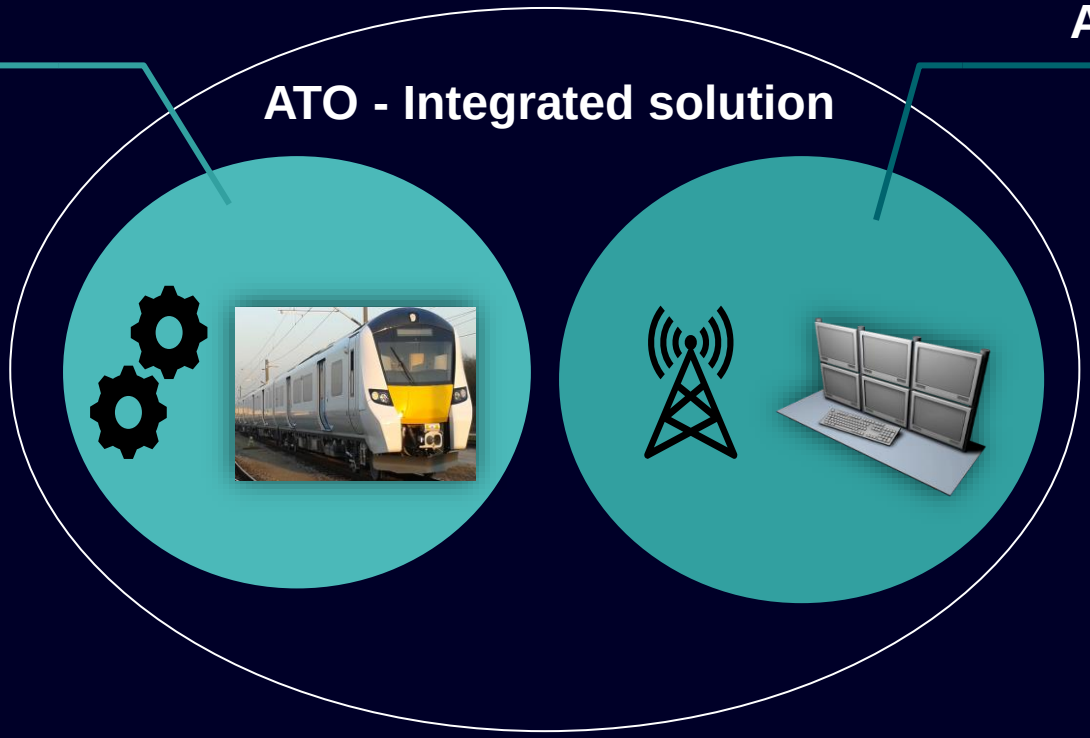
ATO over ETCS - possible migration steps to utilize the benefits of ATO – technology as early as possible

ATO - Onboard

- Pre-fitting of ATO-HW for projects so ATO ready is achieved during ETCS rollout as ATO can be updated and used for all ETCS levels
- Use DAS software (Driver Advisory System) with ATO over ETCS hardware as a first step…



ATO - Trackside

- Install ATO trackside and TMS during ETCS roll-outs
  - Pre-fitting of ATO-TS
  - Pre-engineering (e.g. for “stopping points”)
  - Plan segment profiles for later using the journey profiles of ATO-TS and TMS
- Adaption of ATO-TS to existing infrastructure (TMS)

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ATO over ETCS: Benefits and Challenges

Key benefits

- Reduction of energy consumption and thus contribution to Co2 reduction / European Green Deal
- Standard interfaces between trackside and onboard to ensure interoperability
- Increased punctuality and capacity by train run automation to ensure optimized train run

Challenges

- Push ETCS rollout as a base for ATO
- Proper migration strategy as a railway sector initiative needed due to existing infrastructure and existing train fleets
- Further investigations based on field test are needed:
  → to address adhesion management
  → for control algorithms for freight (driving styles)
  → for further optimizing traffic management control especially in case conflict solving

⇒ **develop a harmonized roadmap for the ATO over ETCS rollout in oder to enable benefits**

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Summary

ETCS Hybrid L3

- Benefits: increase of capacity using existing track infrastructure, better operational quality, reduction of life cycle costs, mixed traffic e.g. ETCS fitted and not-fitted trains possible, fallback in case of communication loss possible
- Challenges: ensure the full alignment and a common vision for the future (ERJU goal)

ATO

- Benefits: standardized interoperable solution improving railway operational efficiency
- Challenges: harmonized roadmap for coordinated ATO rollout

ATO over ETCS and Level 3

- According to trial studies* the combination of ATO over ETCS and HL3 can generate a significant increase of train run capacity to deal with the increasing demands of passenger and freight increase during the next years
- Individual simulation of customer environment necessary to achieve the best individual benefit
- Operational concept should include elaboration of time table and ATO journey profile generation which suites best to railway operation

Sources: Bane NOR: Study report on the effects of ATO and ETCS Hybrid Level 3 Application
IRSE News | Issue 278 | June 2021: “Hybrid Level 3 and ATO: A modelling-based capacity impact study for the Dutch railway network”, Ruben Vergroesen, Alwin Pot and Maarten Bartholomeus