



AŽD Praha s.r.o.

AŽD „Kopidlanka“ line as polygon for Autonomous Railway

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Could you describe the "AŽD „Kopidlanka" line as polygon for Autonomous Railway" in five bullet points short sentences?



- The Kopidlanka line (Kopidlno–Dolní Bousov) is a 24-kilometer regional railway transformed into an experimental polygon for autonomous train testing.
- It features modernized infrastructure including electronic interlockings, ETCS Level 2 signaling, and level crossing protection systems.
- The line is equipped with full GSM-R and 5G coverage for reliable communication and data transmission.
- Control is centralized with a backup center at Dětenice, allowing remote management of trains, signals, and level crossings.
- Kopidlanka serves as the testing ground for the autonomous train EDITA, facilitating real-world trials of autonomous train technologies and operational safety scenarios. [\[1\]](#) [\[2\]](#) [\[3\]](#)



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Leading CEE supplier of control systems for transportation,
Thousands of signalling systems installations in Europe and Asia

Advanced technologies: ETCS, digital railway signalling, integrated traffic management, satellite based train control, automation and autonomous trains, Road telematics all **in-house developed and produced**

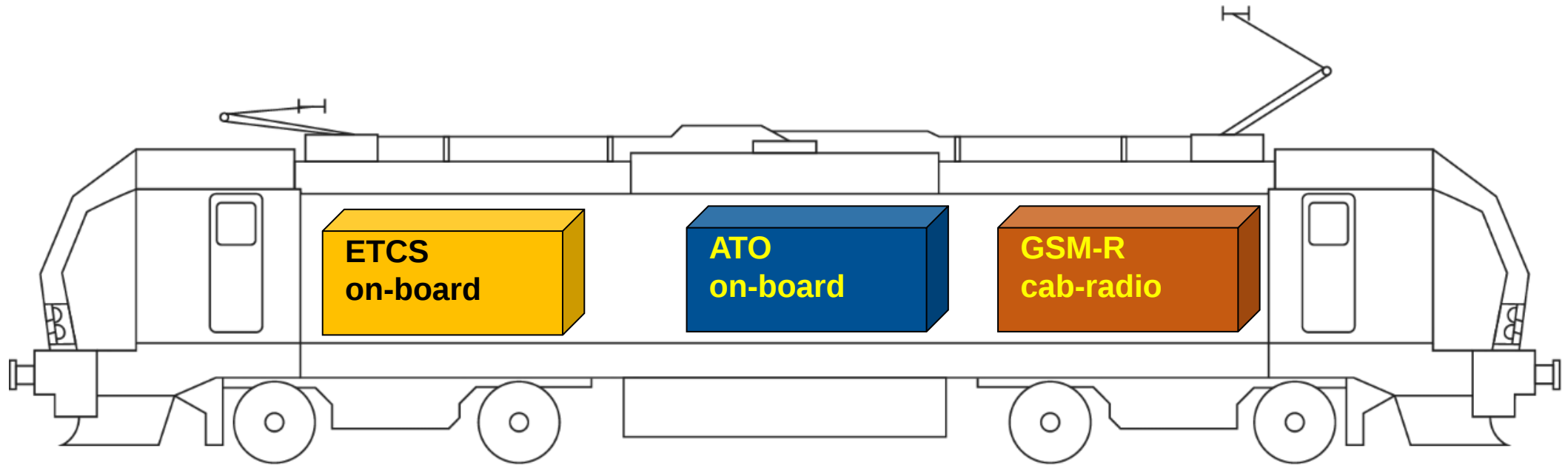
AŽD Praha DNA is built on the pillars of

- SAFETY
- CONTROL COMMAND AND SIGNALLING
- Rail AUTOMATION



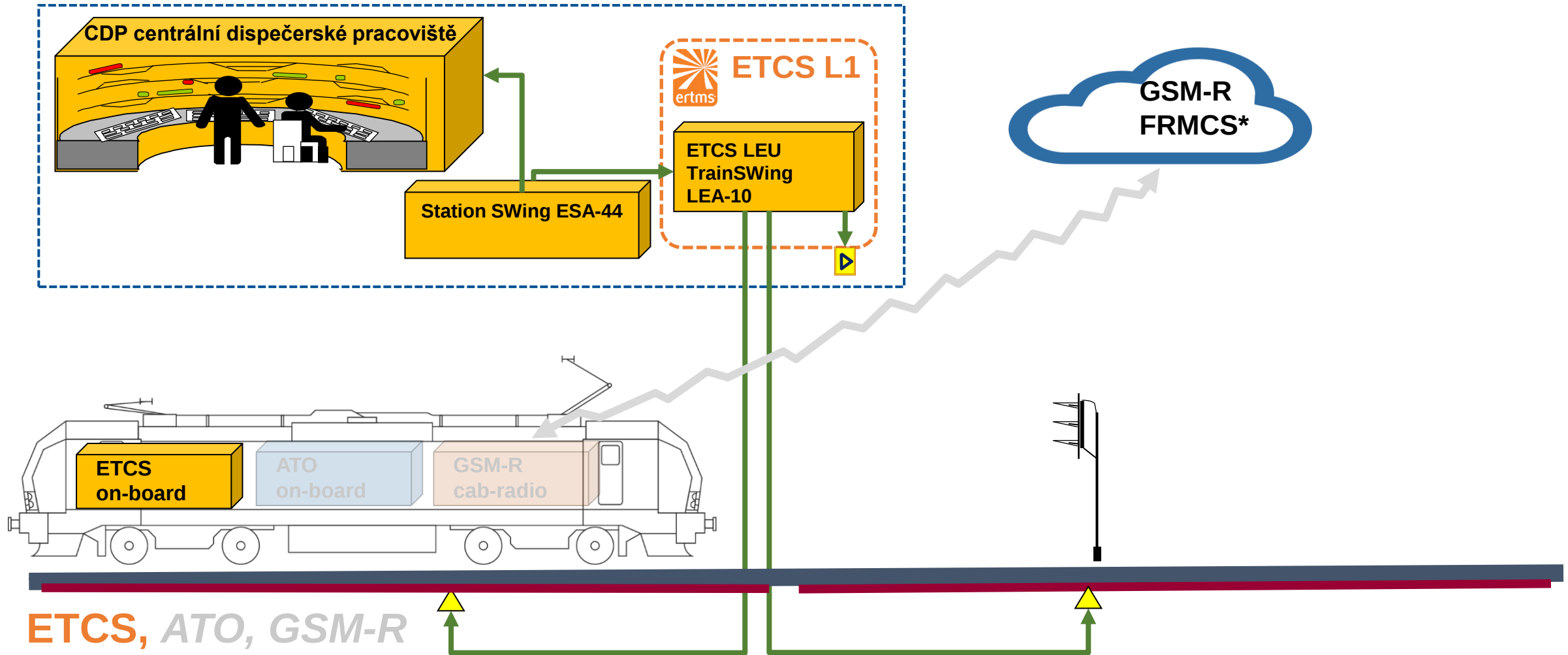
CCS Interoperable railway vehicle

ERTMS (ETCS + GSM-R + ATO)

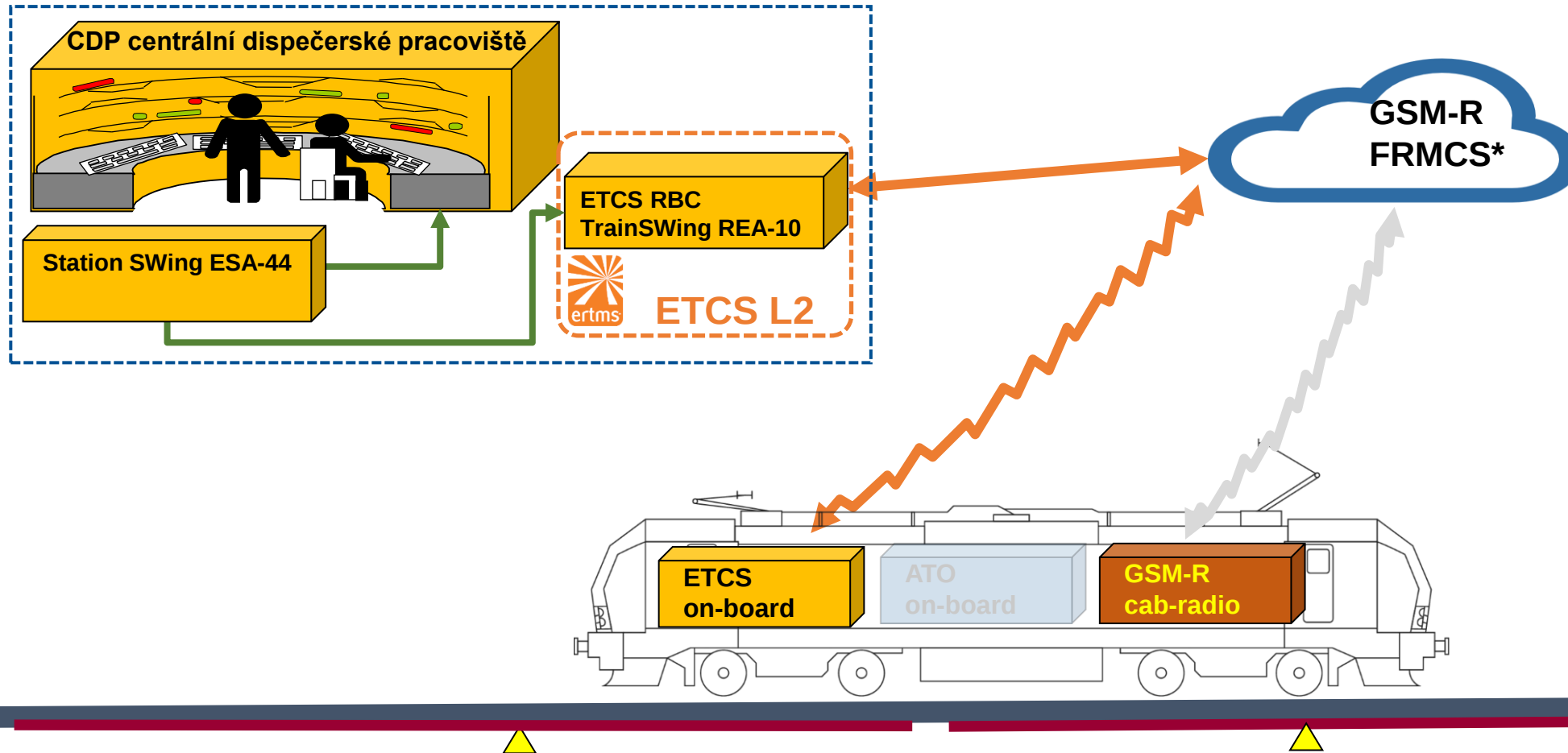


ETCS, ATO, GSM-R

AŽD TrainPatron pro ERTMS/ETCS Level 1

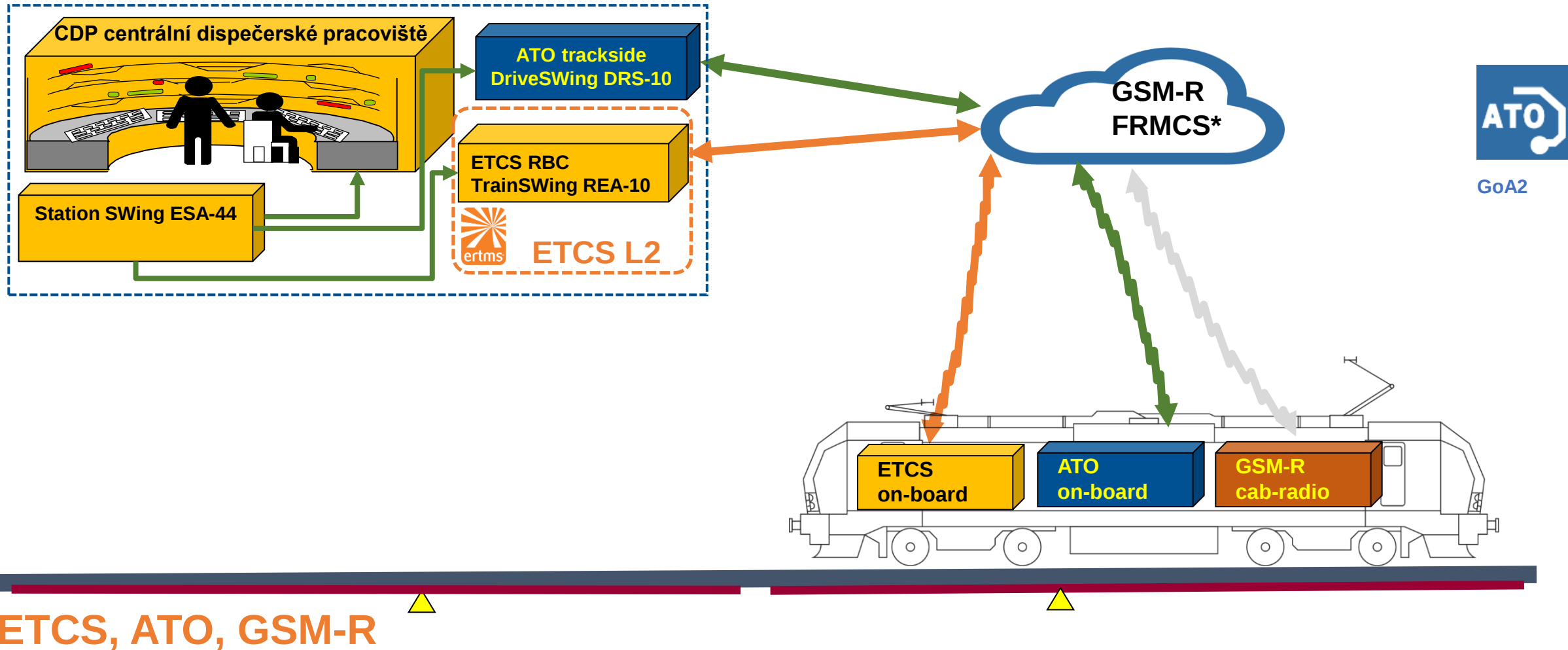


AŽD TrainPatron pro ERTMS/ETCS Level 2



ETCS, ATO, GSM-R

AŽD TrainPatron ERTMS/ETCS L2 + ERTMS/ATO



Using ERTMS, we achieve:

**“SMART, AUTOMATED TRAIN @ SMART
and AUTOMATED INFRASTRUCTURE**

*But we want to go furtherand that means introducing **Autonomy**
into rail transport*

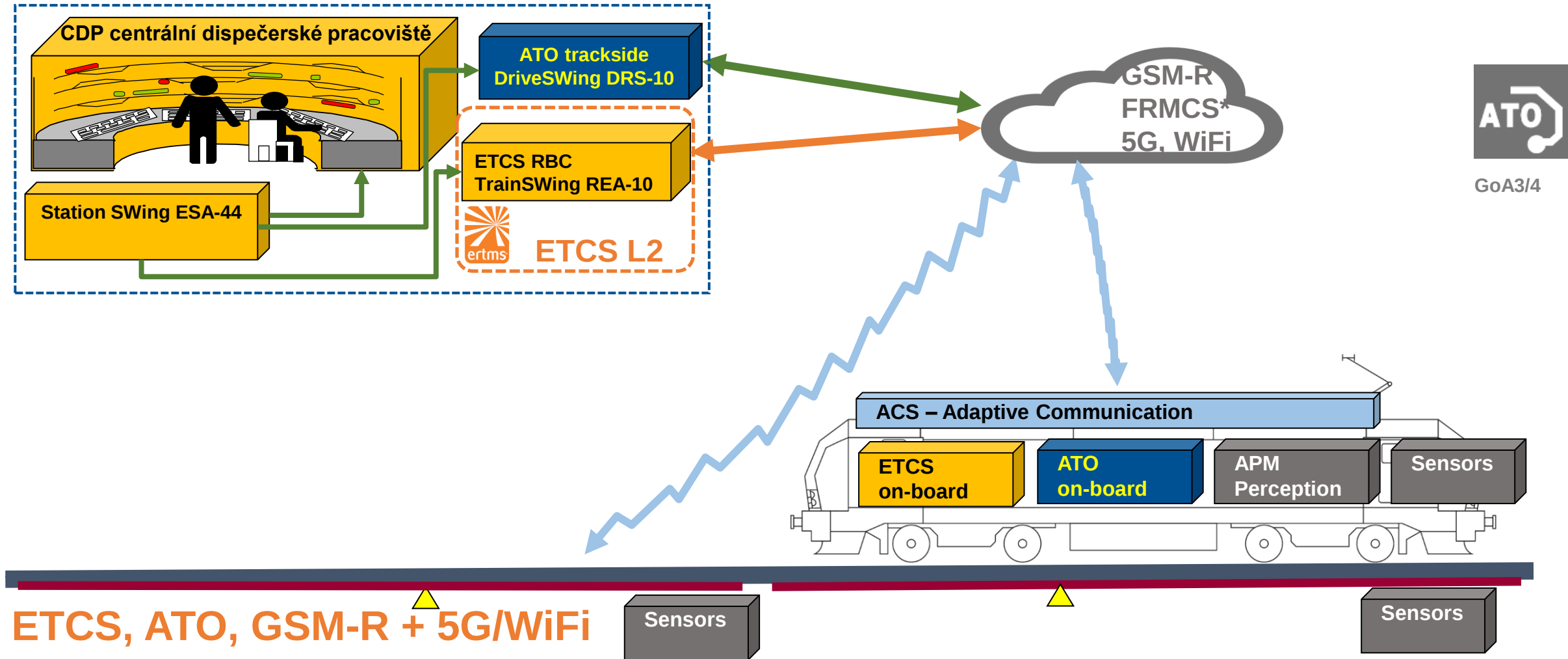
OUR VISION:

AUTONOMOUS RAILWAY:

**“SMART, AUTONOMOUS TRAIN @ SMART
and AUTONOMOUS INFRASTRUCTURE**



AŽD TrainPatron ERTMS/ETCS L2 + ERTMS/ATO





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2015: Opportunity



2015: Opportunity

Dolní Bousov – Kopidlno

Length of the line: 22.37 km

Gauge: 1435mm

Braking distance: 400 m

Single-track

Traction system: independent

Without regular service since 2010

Maximum speed: 60km/h

NO SIGNALLING, NO RADIO SYSTEM

KOPIDLNKA

Čížkovice - Obrnice

Length of the line: 35,892 km

Gauge: 1435 mm

Braking distance: 400 m

Single-track

Traction system: independent

Without regular service since 2007

Maximum speed: 50km/h

NO SIGNALLING, NO RADIO SYSTEM

ŠVESTKOVKA (PLUM RAILWAY)





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“Švestkovka” line: Test polygon





VIDEO

Švestková Dráha / Plum Railway



„Švestkovka“ Test Polygon – Installed technologies

CCS systems	Type
Railway Interlocking	AŽD, type StationSWing ESA 44
Train detection	Axle counters covering the whole line, type Frauscher FaDC
Level Crossings	GateSWing line of levelcrossing types from AZD production
Remote track control	AZD TrafficSWing DOZ-1 controlled from Litoměřice
ERTMS/ETCS	AZD TrainSWing ETCS L2 and L1
Diagnostic system	AZD DiagSWing LDS-3/GDS
Traffic management system	AZD TrafficSWing GTN-4 with Automatic Route Setting

Communication Services	Type
Telecommunications	GSM-R coverage – the whole track
Communications	WLAN – 2 km at Libčeves
Passengers services	Voice announcement and Passenger information system at the whole track



Regular passenger operation at Plum Railway

- Daily operation since 15.12.2019
- 11 (eleven pairs) of trains running between Litoměřice and Most
- another 7 (seven pairs) in the section Litoměřice – Třebívlice
- Outlook for next contract



„Švestkovka“ Test Polygon

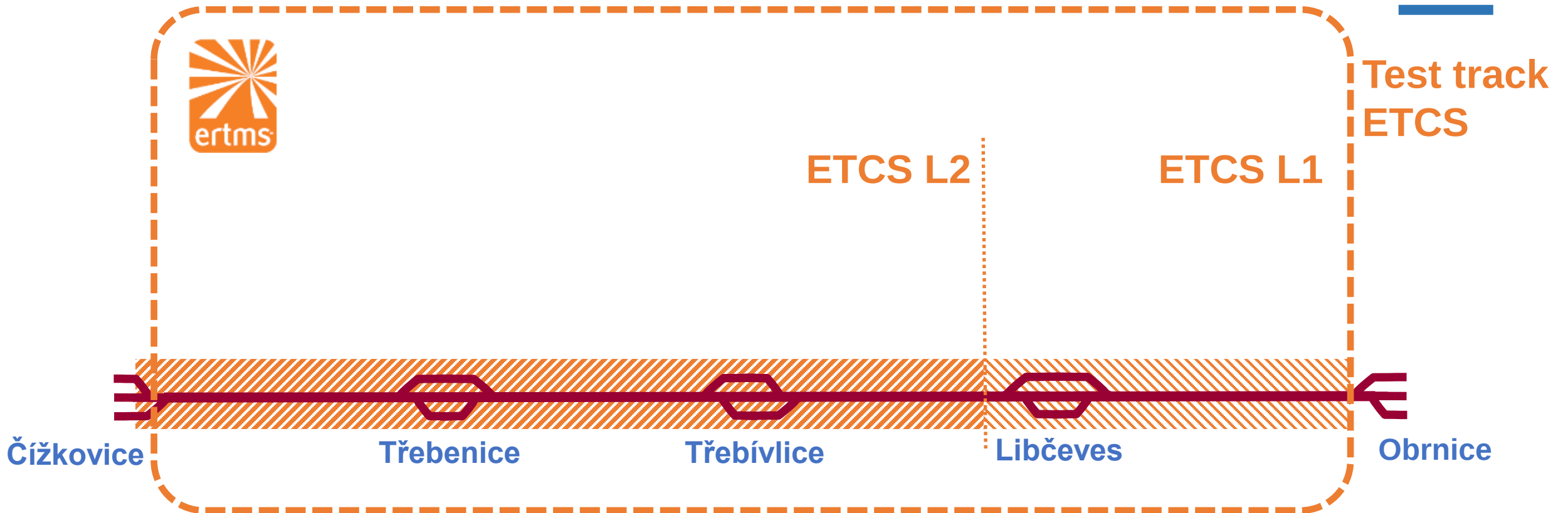


„Švestkovka“ Test Polygon

ATO GoA3/4

ACS - Adaptable
Communication System

ATO GoA2
ERTMS/ATO TS

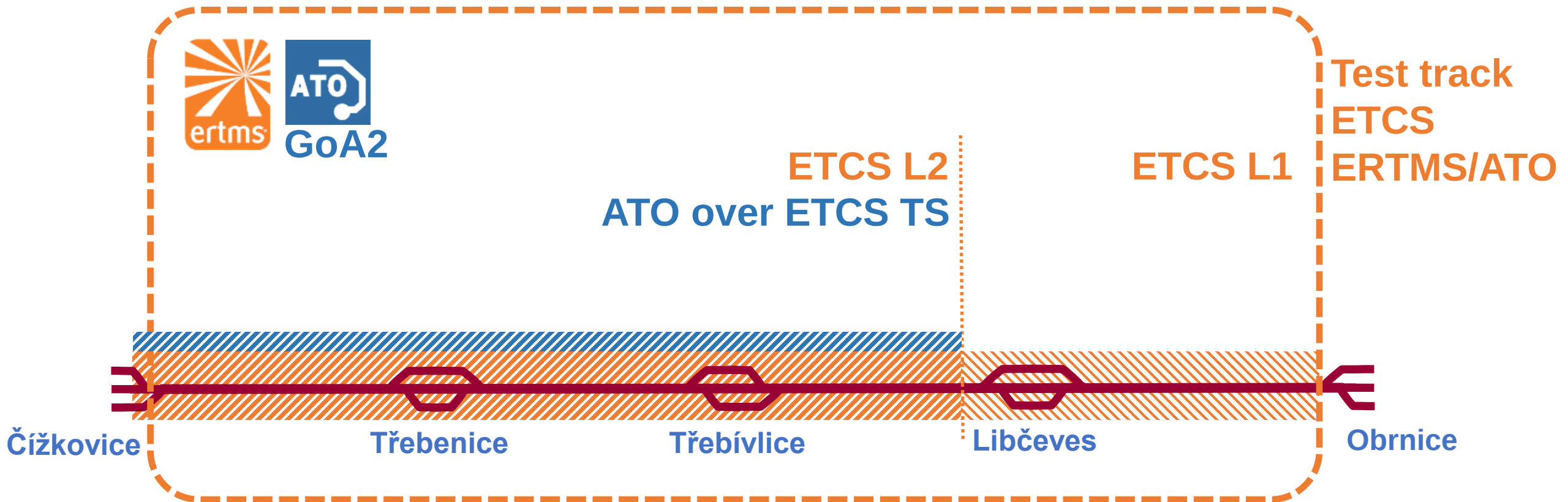


„Švestkovka“ Test Polygon

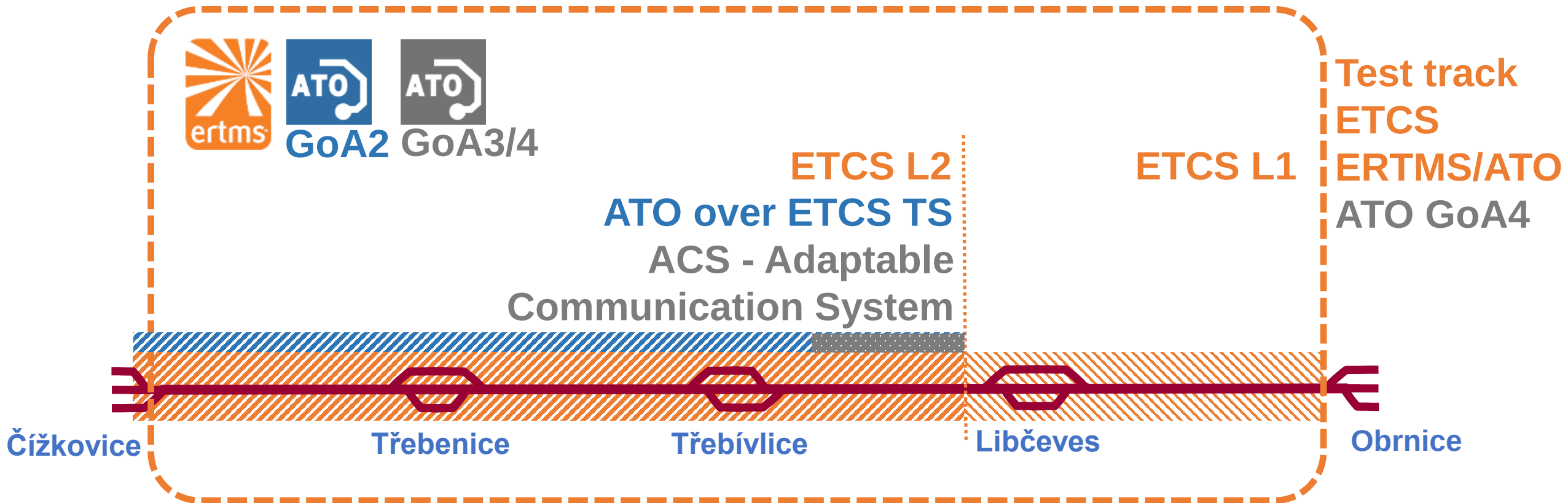


GoA3/4

ACS - Adaptable
Communication System



„Švestkovka“ Test Polygon



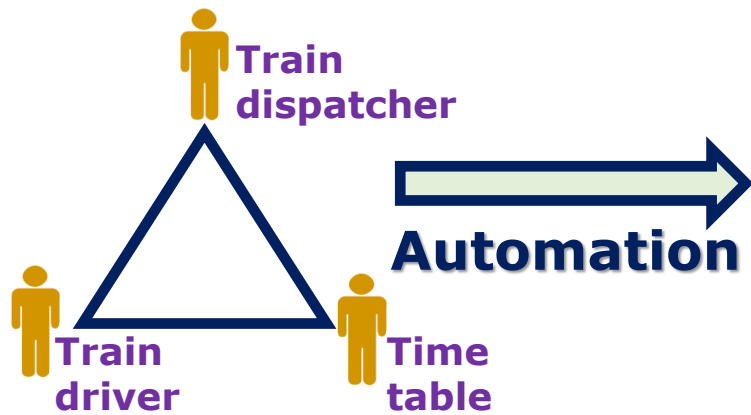


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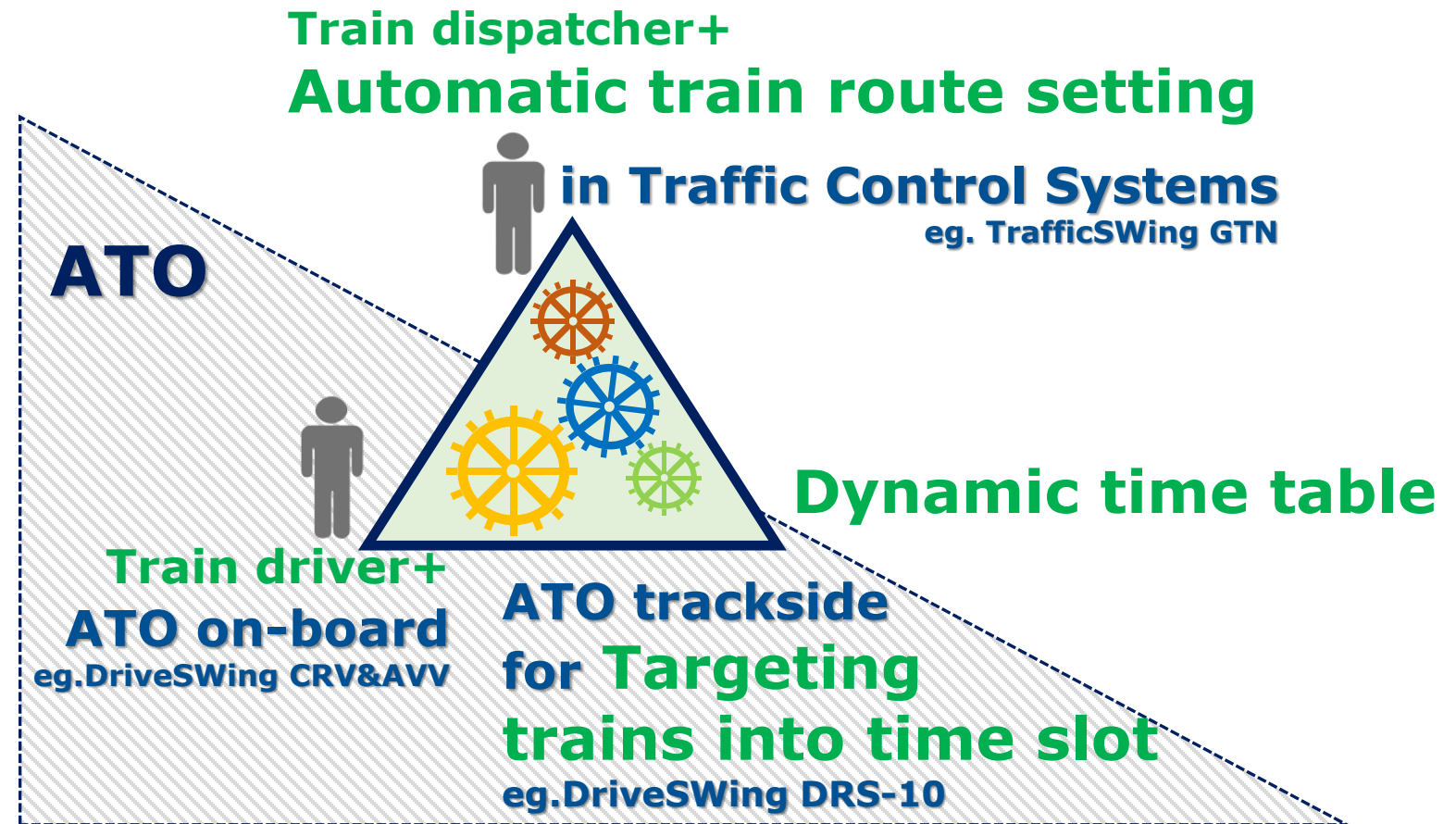
ATO: Key element for Autonomous Train



3 pillars of rail traffic automated operation



- TARGET: Increase capacity and effectiveness with ensuring same or increasing level of safety
- TARGET: Elimination of routine operations and computerized support for decision making process



ATO history in Czech Republic

1960's

60's - first tests with ATO systems (Speed Regulator, Automatic Target Braking Subsystem and Energy Saving Subsystem)

1980's

Full (analogue) ATO were under tests in commercial operation.

1991

Digital solution ATO, Class 470 EMUs equipped
Digital ATO in everyday operation for 30+ years

1996

Since class 471 all new EMUs are equipped with digital ATO during their manufacturing



ATO testing DMU
class M 286.1



ATO test loco 242.256 (1985)



EMU 470.001-002 with
commercial ATO (1996)



Kopidlno line: Test polygon for Autonomous Railway

ATO history in Czech Republic

2008

Unit 471.042 was equipped with ATO over ETCS (AoE) in 2008 as one of the **first in the world**.

2010

ATO at 30% of CZ railway network,
≈ 90% of total transport performance

2020

Oct 19. **Worldwide** premiere of AoE for freight train, Switzerland. Shift2Rail demonstrator.

2021

AŽD: Švestková dráha equipped by AoE

2025

AŽD: Kopidlno equipped by AoE + GoA3



(2008) Unit 471.042 with
ATO over ETCS



19.10.2020 Sierre – Sion, CH
185 141-9 DB Cargo

ATO commercial operation in Czech Republic

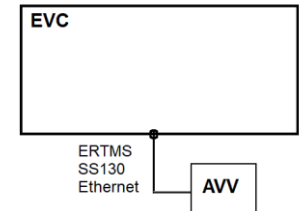
TODAY

- ATO lines **3500 km** (of 9500km) at **Czech Railway network**
- Running more than **400 vehicles (600)** with **ATO type AVV**
- ATO Performance: Target braking accuracy $\pm 0,5\text{m}$, just-in-time arrival $\pm 5\text{ sec}$, energy savings 10-30%
- All ETCS On-board installation with ATO AVV re-attached as **ATO AVV over ETCS**

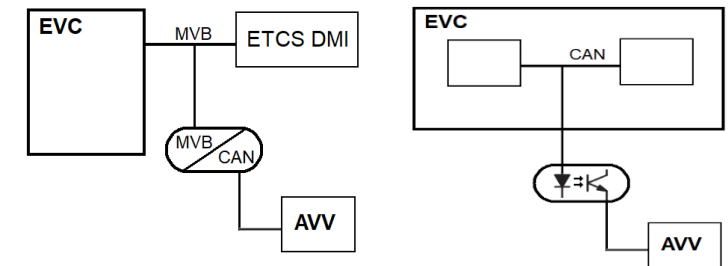
→ Using ETCS balises instead of AVV MIB balises

TOMORROW

- ATO AVV ready for upgrade to ERTMS/ATO
- Implementation of ERTMS/ATO TS
+ on-line infrastructure changes management
- Removing AVV MIB Balises from infrastructure



ATO AVV over ETCS
Compatible ETCS on-board
According TSI CCS specifications



ATO AVV Over ETCS
For ETCS non compatible on-boards

AŽD ETCS Test Train



VIDEO ATO GoA3 DEMO at Innotrans 2022



Kopidlanka" line: Test polygon for Autonomous Railway



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“Kopidlanka” line: Test polygon for Autonomous Train Operation



„Kopidlno“ – Installed technologies

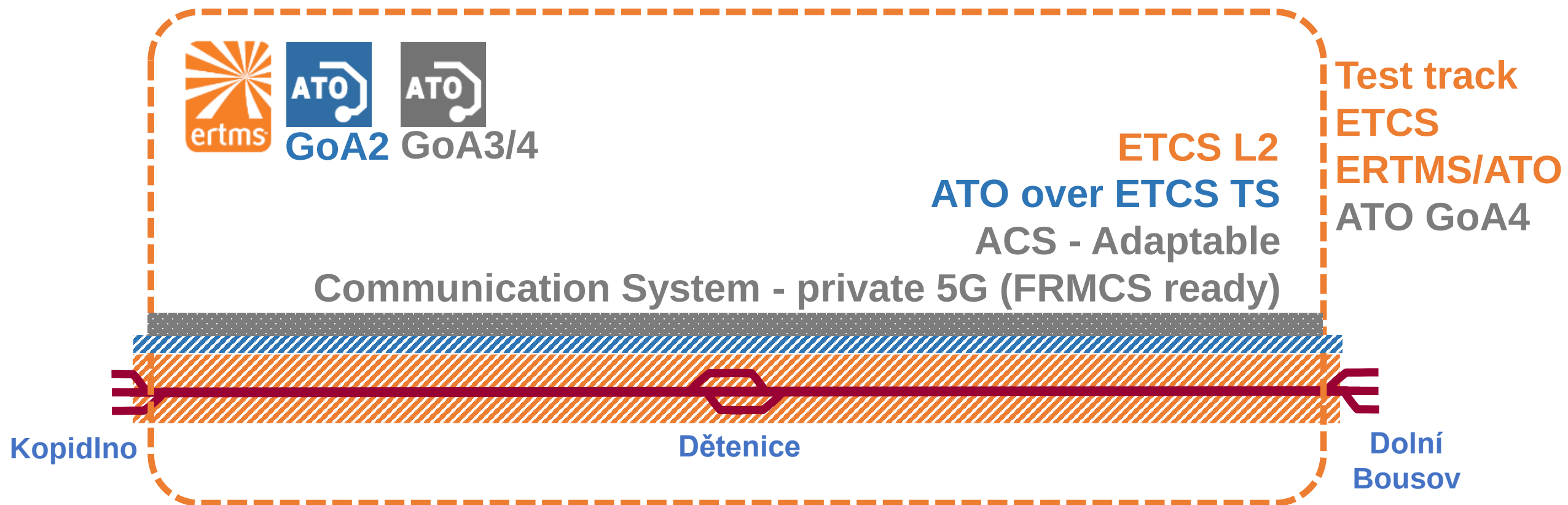
Conventional CCS systems	Type
Railway Interlocking	AŽD, type StationSWing ESA 51
Train detection	Axel counters covering the whole line, type Frauscher FaDC
Level Crossings	Different GateSWing types from AZD production (9x PZZ-J, 6x PZZ-GTS for securing level crossing in the track, 5x PZZ-ACE for level crossing in stations (Dětenice, Dolní Bousov), light warning system for pedestrians in Dětenice type AŽD VZPK
Automatic block system	AZD TrackSWing AHP-03D (Dolní Bousov – Dětenice) - partially using GSM-P, AH-ESA in segment Dětenice – Kopidlno
Centralised track control	AZD TrafficSWing DOZ-1 controlled from Kopidlno
ETCS	AZD TrainSWing ETCS-L2 (the whole track)
Diagnostic system	AZD DiagSWing LDS-3
Traffic management system	AZD TrafficSWing GTN (local dispatching system) with automatic route setting

Services	Type
Telecommunications	GSM-R coverage – the whole track
Security	Video Surveillance System
Passengers	Voice announcement and Passenger information system at Dětenice railway station

Support for autonomy	Type
Level crossings	Clearance control of level crossings (Laser scanner, ADEROS camera system)
Communications	Private 5G radio network
Maintenance	Autonomous inspection cart



„Kopidlno“ Test Polygon for Autonomous Train Operation



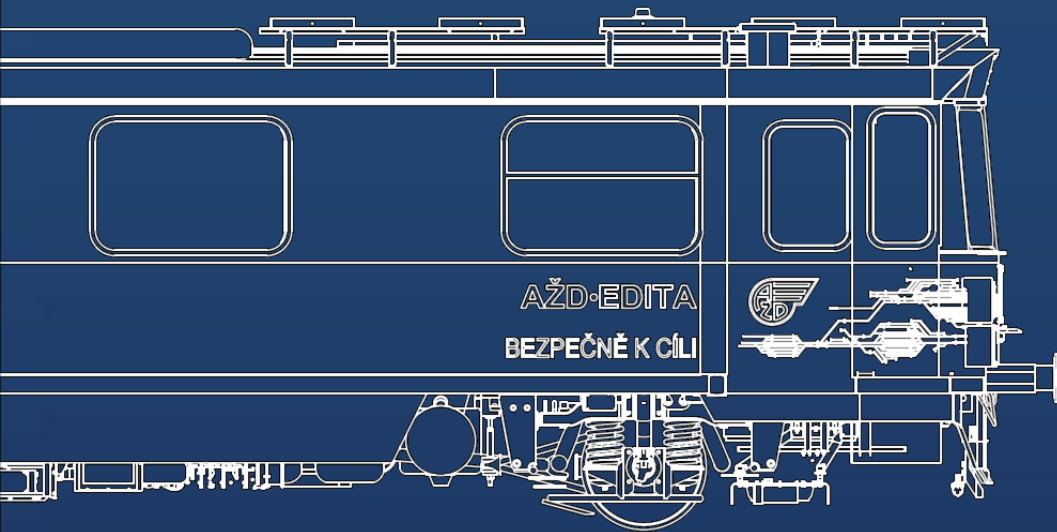
Railway Competence Center Dětenice





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Autonomous Train



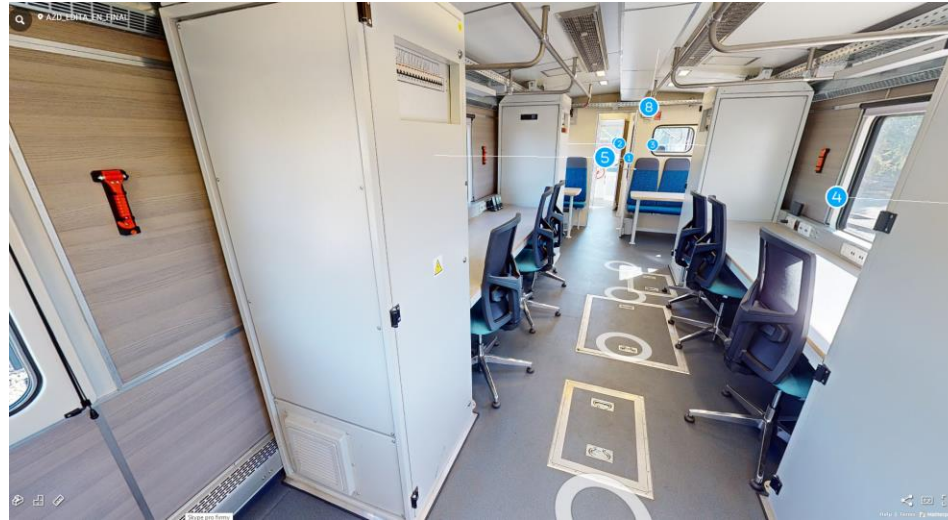
Autonomous vehicle from „Blue Crocodile“ (MV ETCS) to „EDITA“

- Ad-hoc installed sensors → Embedded sensors
- Internal architecture → based on ERJU architecture - (new modules)
- Improvement of the PERception software solution + increased robustness by independent threads



AŽD GoA3/4 test car „EDITA“

- EDITA = **E**xperimental **D**riverless vehicle for **I**nnovation and **T**echnologies of **A**ZD
- Completed in 2024 as a complete refurbishment of 1976' diesel passenger railbus class 810
- Built specifically for research, development and testing of autonomous technologies
- Set of sensors, cameras and detectors built-in at each end of the car
- No seats for passengers



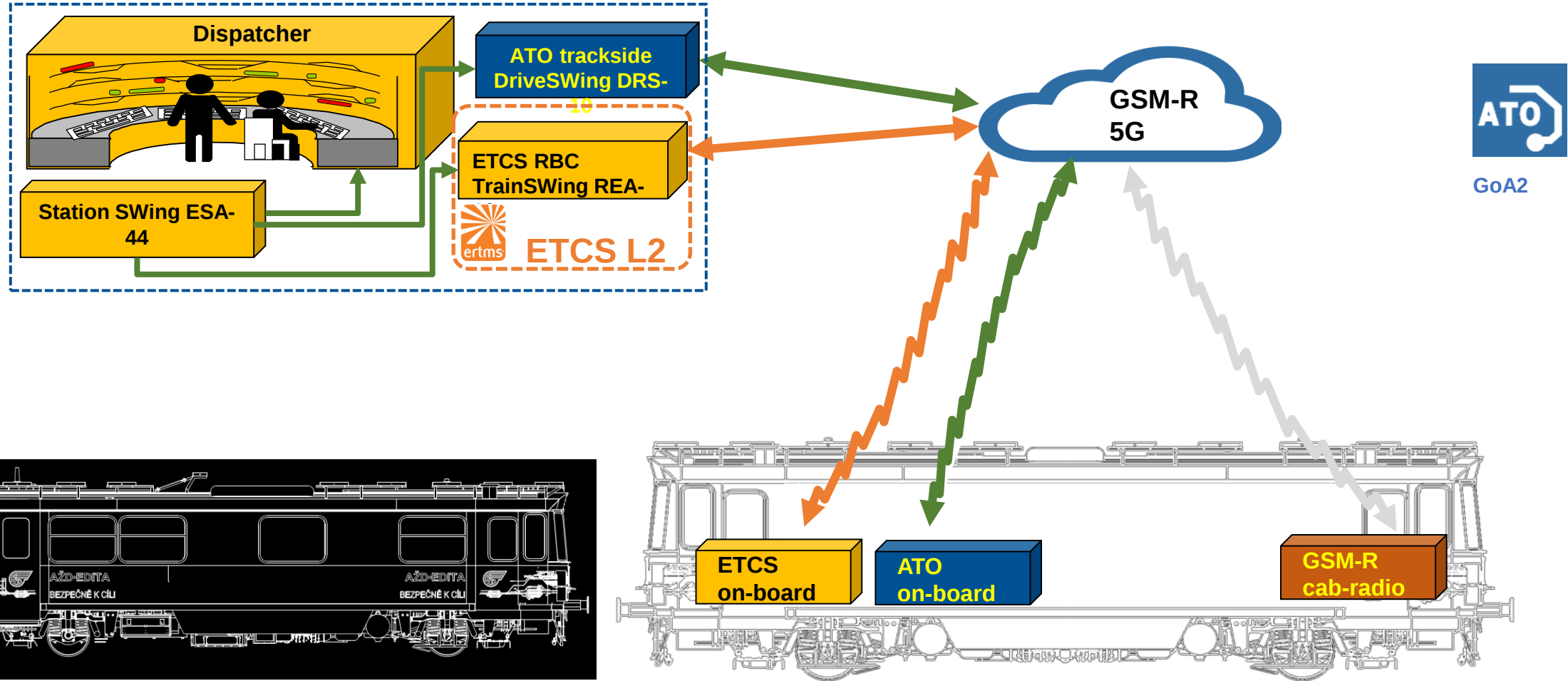


Grade of Automation (GoA)

		Grade of Automation	Train supervision	Train control	Supervision of area in front of train	Closing the door	Permission to depart from station
		GoA0	Train driver	Train driver	Train driver	Train driver	Train driver
		GoA1	System	Train driver	Train driver	Train driver	Train driver
30 year-anniversary of GoA2 commercial operation in Czechia	GOA →	GoA2	System	System	Train driver	Train driver	Train driver
2025 public service	→	GoA3	System	System	System	responsible operators	responsible operators
ongoing Research and Development; future aim + required changes to legislation	→	GoA4	System	System	System	System	System

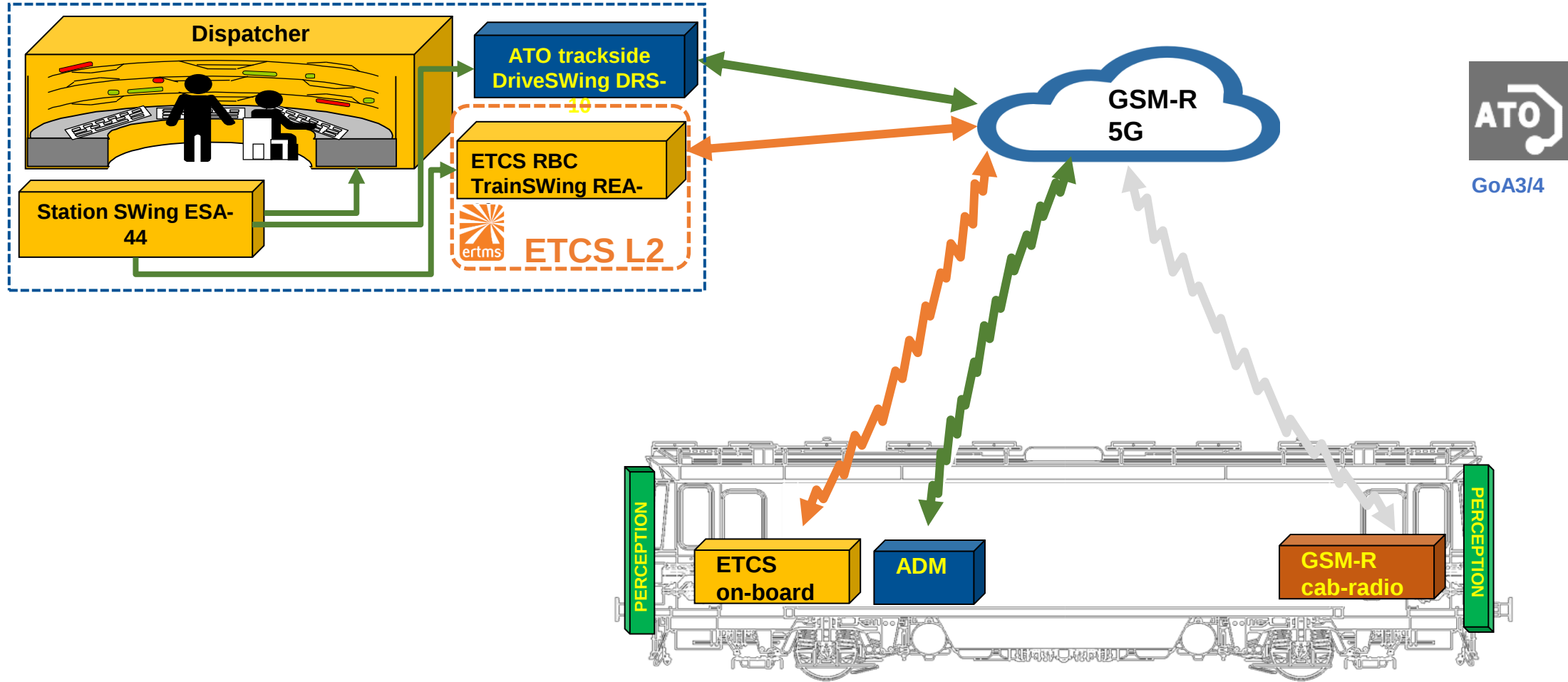
Responsibility: ■ System ■ Train driver/responsible operators

Autonomous train in GoA2



ETCS, ATO, GSM-R + 5G

ATO GoA2 -> ADM

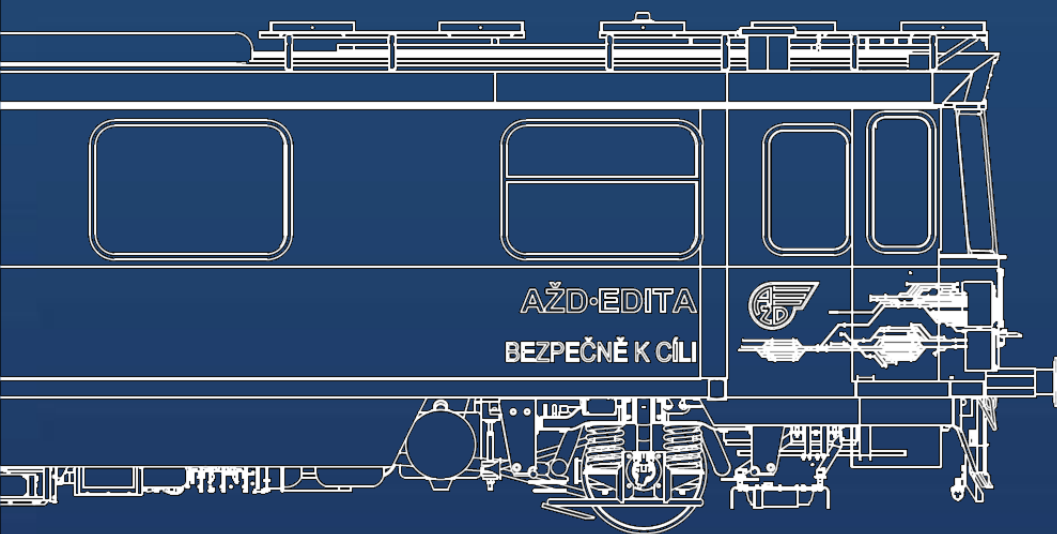


ETCS, ATO, GSM-R + 5G



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EDITA – systems and modules

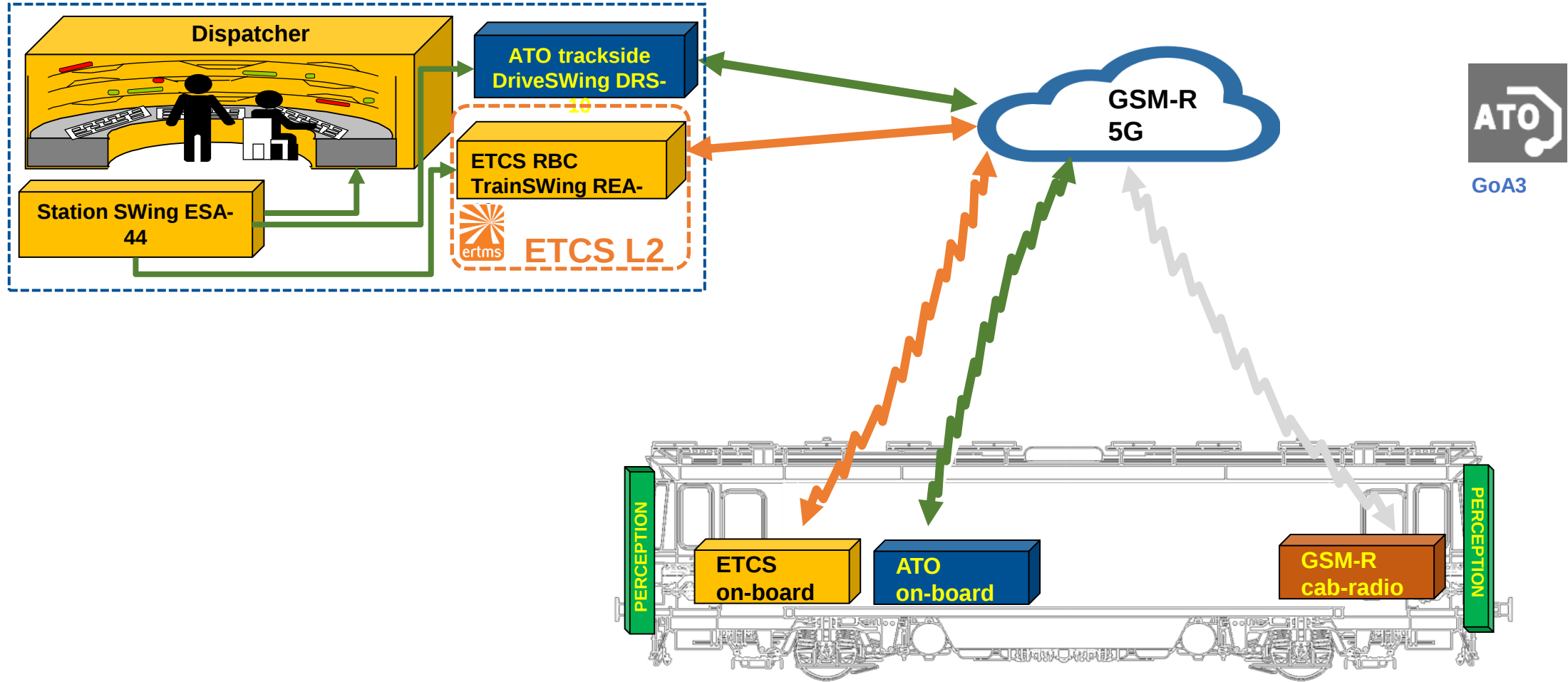


Automatic Driving Module (ADM) – GoA 3-4 ATO

- Extension of our GoA 2 interoperable ERTMS/ATO („ATO over ETCS“) to support fully autonomous operation
- Regulates traction and brake of the train to achieve fulfillment of the timetable (Journey profile) in an energy-efficient way, by taking into account the characteristics of given line description (Segment profile)
- Feedback between ADM/ATO and TMS through ATO-TS (ERTMS Subset-126)
- Built using our 30-year experience with GoA 2 ATO in commercial operation
- Interfacing PAL & ETCS-OBU via ERTMS Subset-130
- Interfacing TCMS via ERTMS Subset-139
- Interfacing GoA 3-4 specific subsystems via draft X2R-4 and R2DATO interfaces



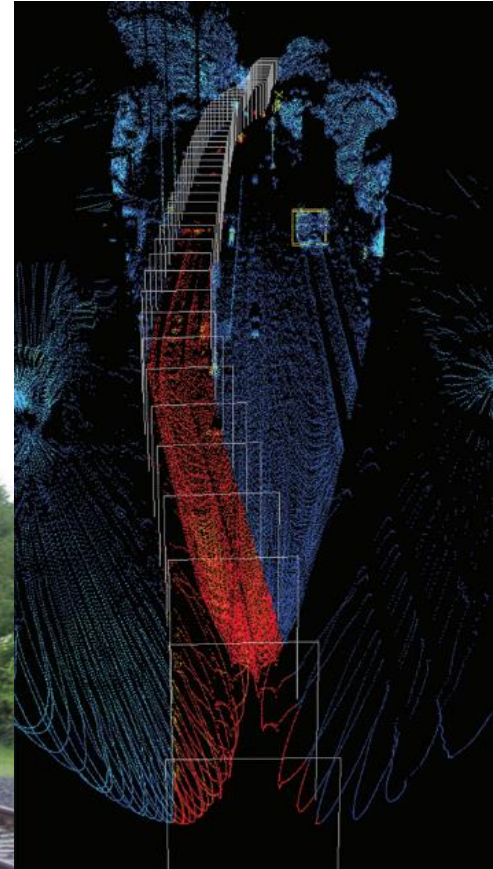
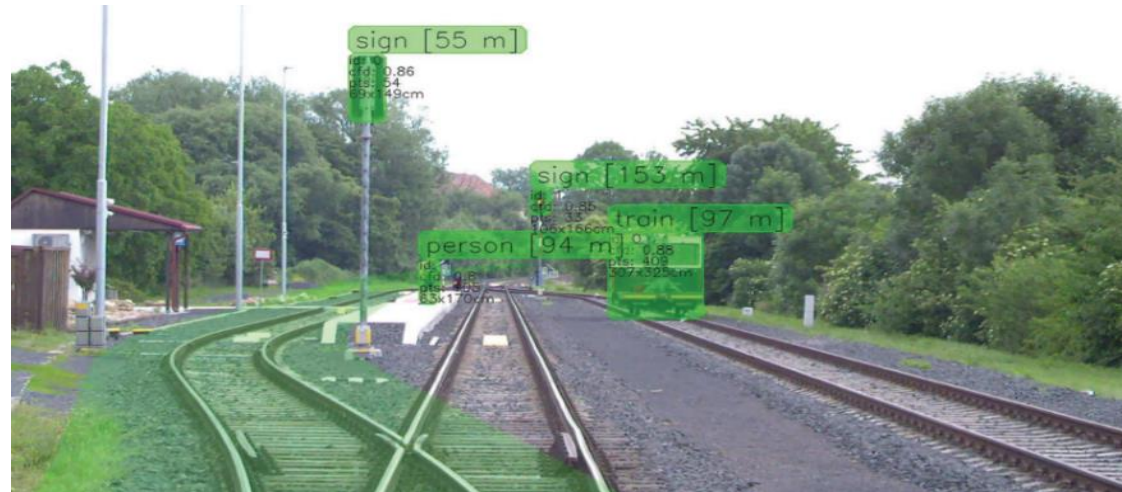
Perception



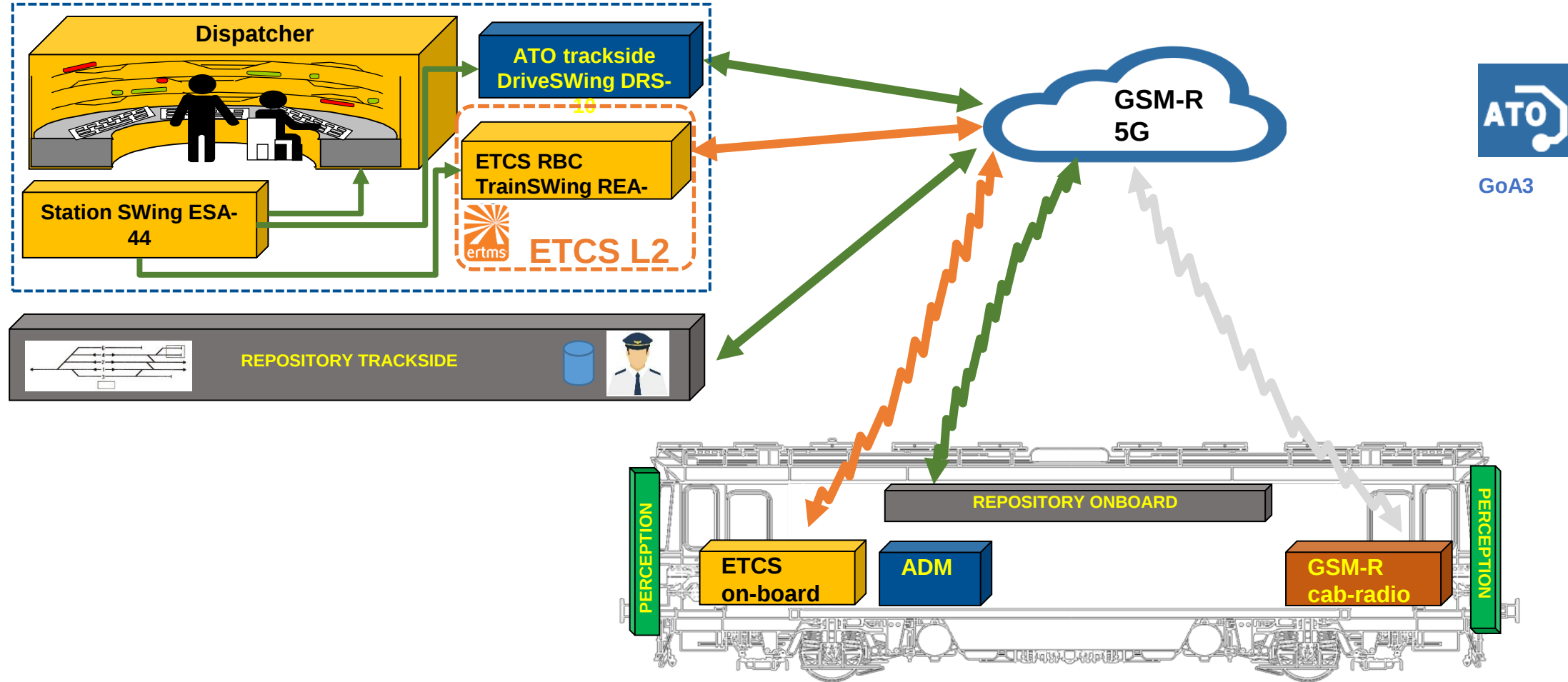
ETCS, ATO, GSM-R + 5G

Perception module

- „System to replace driver’s eyes“
- Based on Deep learning, neural networks, image and pattern recognition
- Set of sensors to evaluate clearance of the track ahead; to detect obstacles
- Pair of cameras with different focal lengths, two LiDARs with IMU and an infrared camera on each head of train

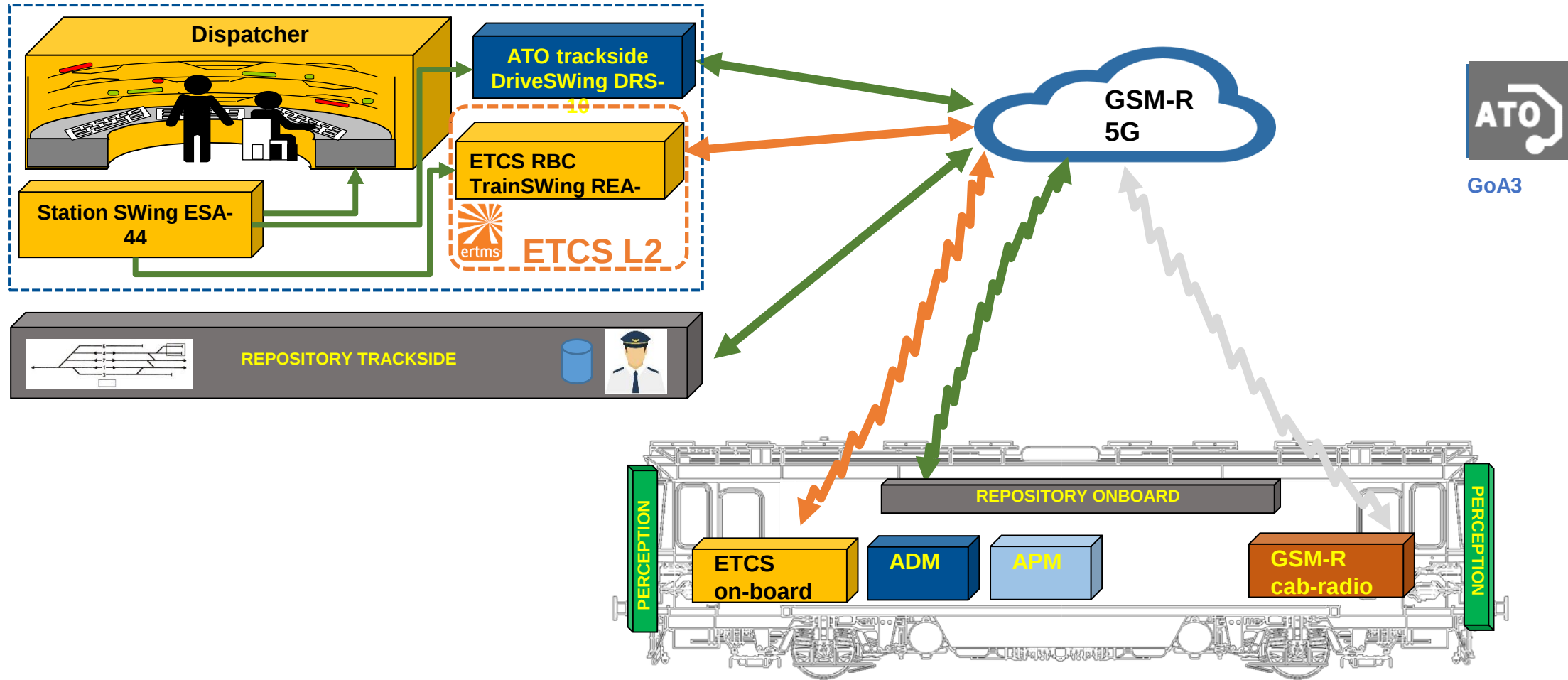


Repository (On-Board and Trackside)



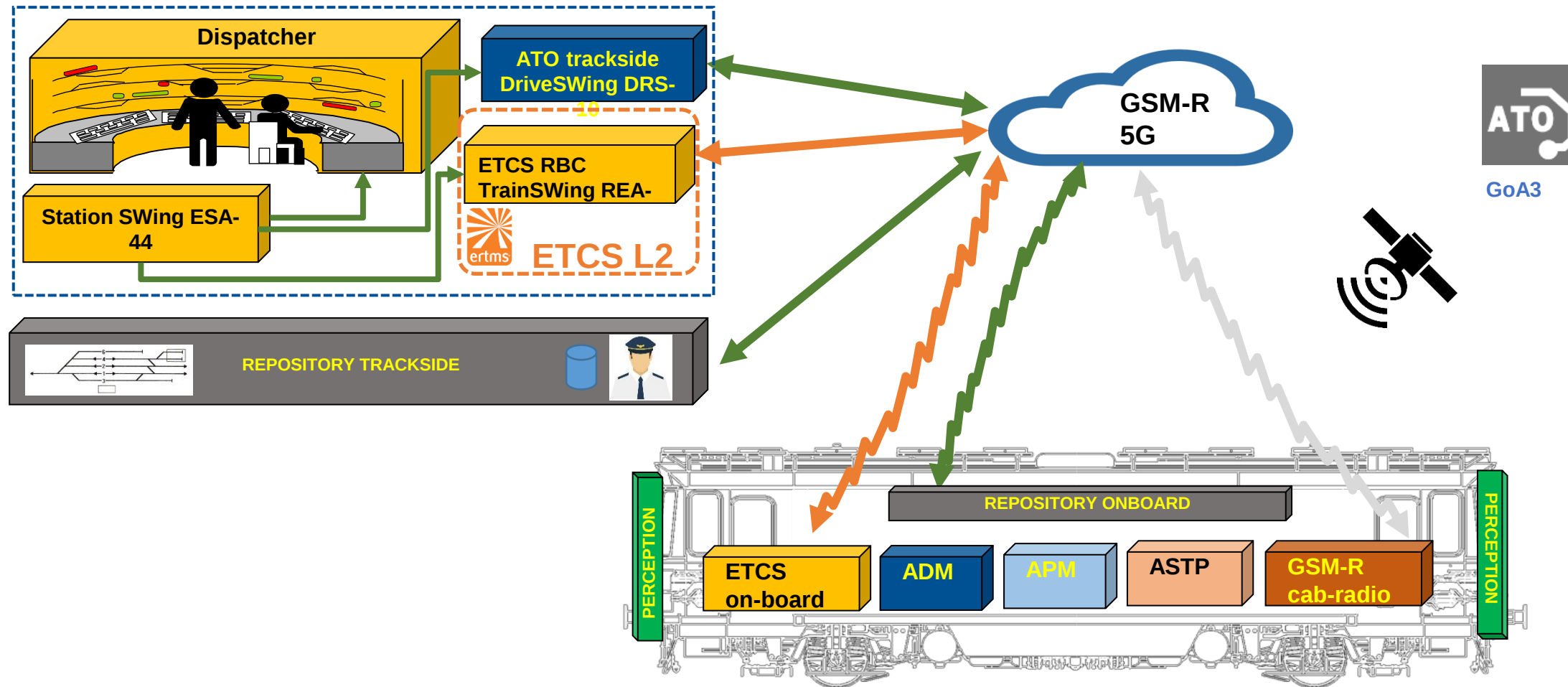
ETCS, ATO, GSM-R + 5G

APM – Automatic Processing Module



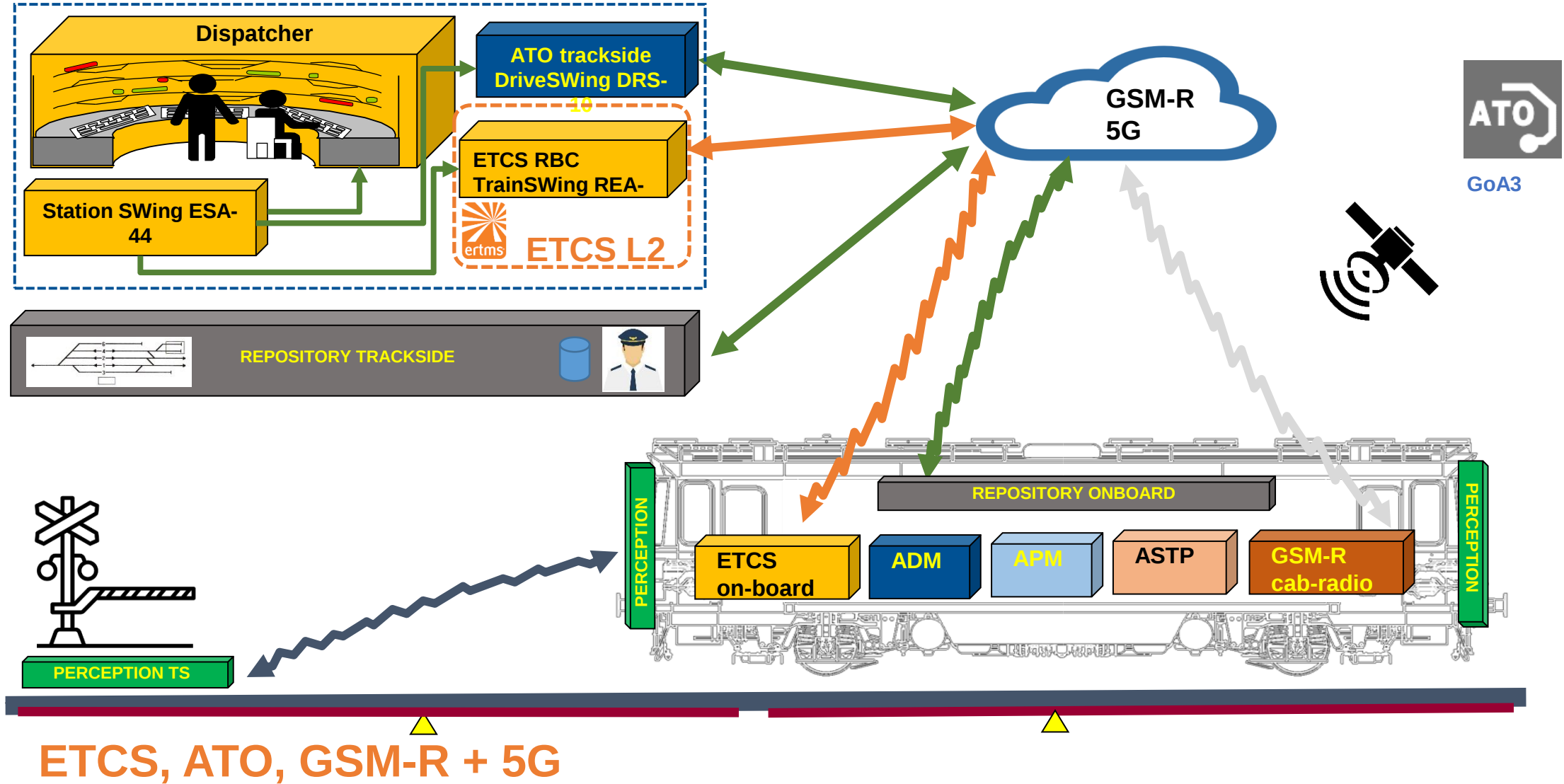
ETCS, ATO, GSM-R + 5G

ASTP Absolute Safe Train Positioning

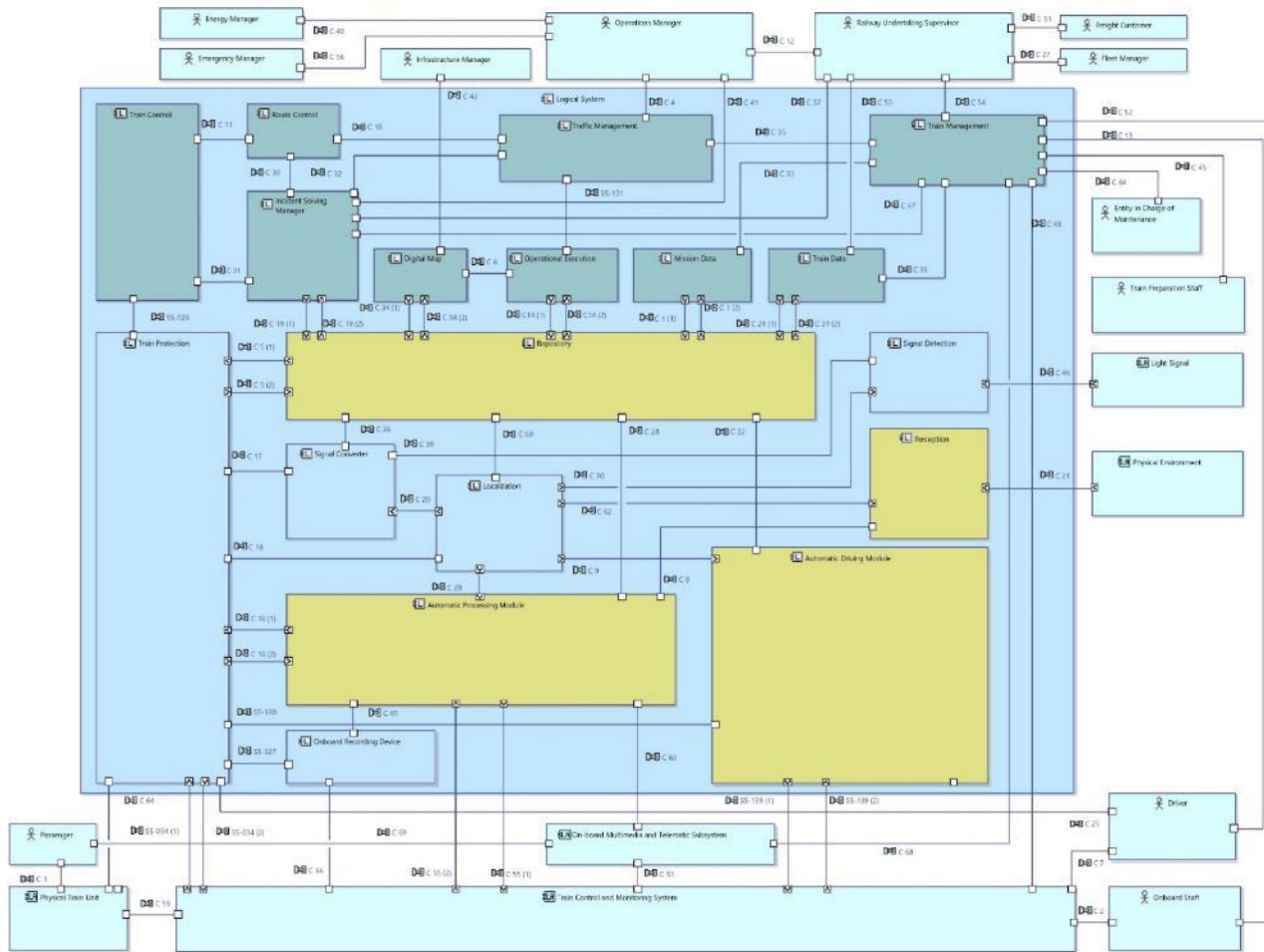


ETCS, ATO, GSM-R + 5G

Trackside Perception



X2R-4 & EU-RAIL ATO GoA 3-4 Architecture



- Initial GoA34 Architecture and tests in Czechia

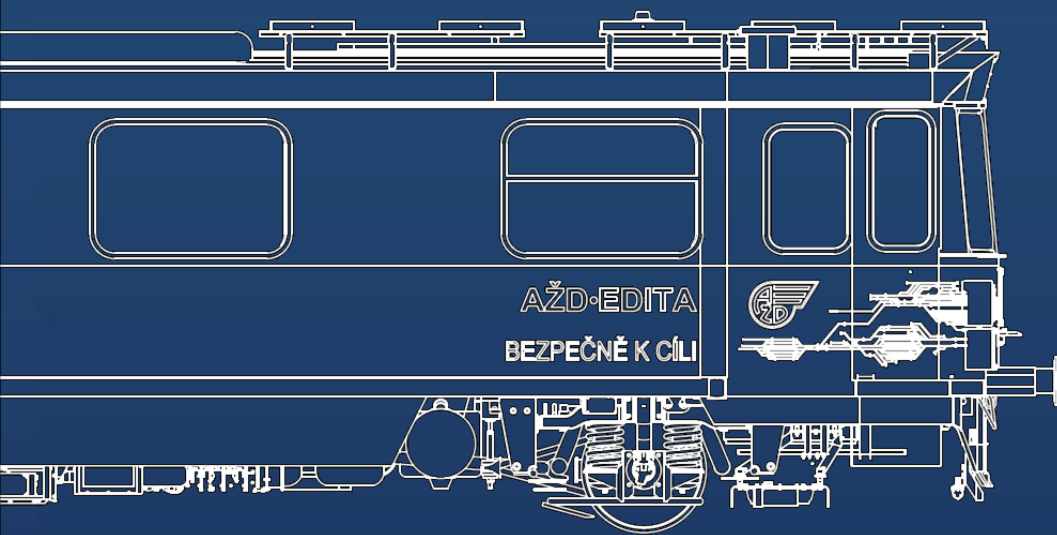


- WP5 and WP6 of R2DATO project: Updated specifications
- WP46: Regional line demonstrator
 - Validate the specification
 - Test of modularity principles
 - Cooperation with ALSTOM, WABTEC and INDRA



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EDITA – operational scenarios



EDITA Autonomous train – operational scenario

■ Phase 1 GoA0

- **Driver** performs the **standard locomotive checks** before departure: operational fluids, checks vehicle diagnostics, braking system, Train control devices, Engine status, etc.
- **Manual coupling of passenger coaches** (locomotive run-around, coupling).
- Driver **logs the train into ATP** (ETCS) to ensure train movement protection.

EDITA Autonomous train – operational scenario

■ Phase 2 GoA1

- Train protection system performs **calculation of static and dynamic data for train drive**.
- **ADM (ATO) module activated** to enable automatic train operation.
- ADM initializes the **download of current timetable data** from TMS (Journey profile).
- ADM initializes the **download of track data** (Segment profile: Gradients, Speed restrictions, protected segments, etc.).

EDITA Autonomous train – operational scenario

■ Phase 3 GoA2

- Train **automatically departs to the platform** according to the timetable.
- Train **passes an ETCS balise group**, obtaining a secured position (localization in ETCS system).
- Train **automatically stops at the platform**.
- GoA3 modules activated: Perception, ASTP, APM.
- Boarding completed and **doors manually closed**.

EDITA Autonomous train – operational scenario

■ Phase 4



GoA3

- Train checks **conditions for autonomous departure**:
 - A. Movement Authority received from the interlocking / ATP*
 - B. Confirmation of closed doors available*
 - C. No obstacle detected in front of the train*
 - D. Driver confirms presence (legal requirement)*
- **APM emulates driver actions** and issues the departure command.
- **Perception** continuously **monitors for obstacles**; if detected, train reacts by reducing or stopping (ETCS ensures safe stop).
- **Train automatically stops** at the next scheduled station.

Welcome aboard on our journey into the future!

Vladimír KAMPÍK, MIRSE
Peter GURNÍK



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