



AŽD Praha s.r.o.

Autonomous railways – Deep dive - technology, visions and reality

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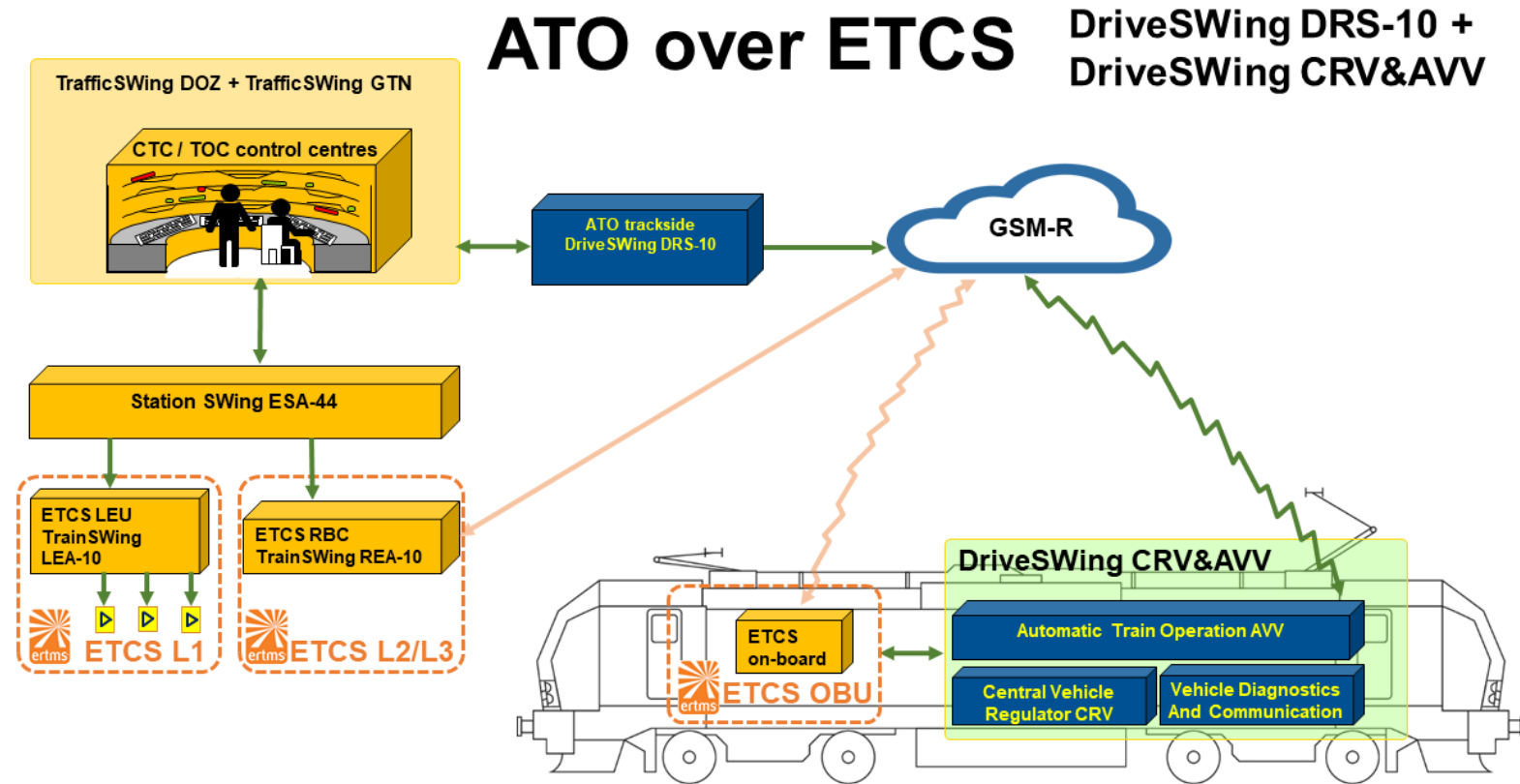
Topics

- Evolution of automation
- Technologies for GoA3/4 developed by AZD
- Autonomous vehicle EDITA
- Path towards autonomous railways



Current state – open railway lines - AoE GoA2

- ATO-TS and OB unit
 - GSM-R (GPRS) comm.
- Dynamic data Exchange
 - Departure times (JP)
 - Planned routes (SP)
- GoA2 – automatic train movement with driver
 - Tested on the AZD Plum line
 - In Switzerland / Great Britain

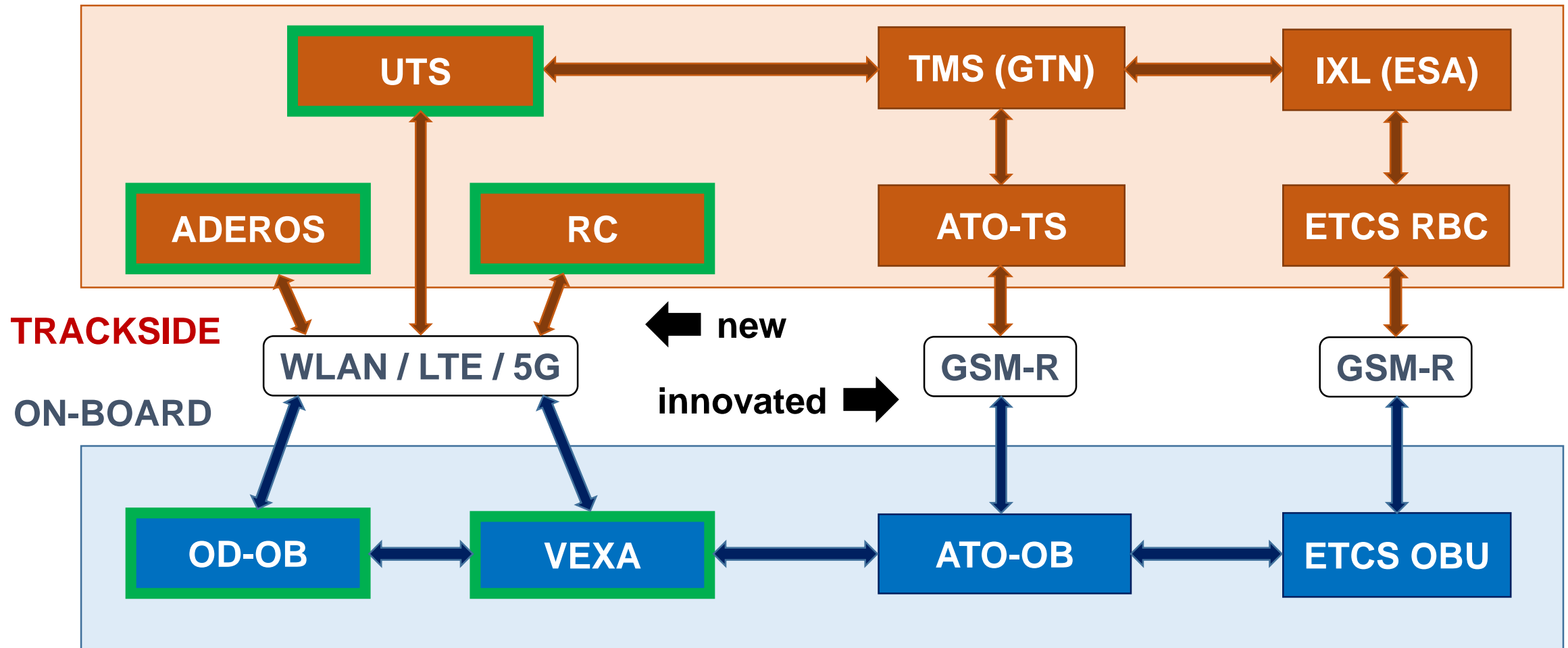


From GoA2 to GoA4

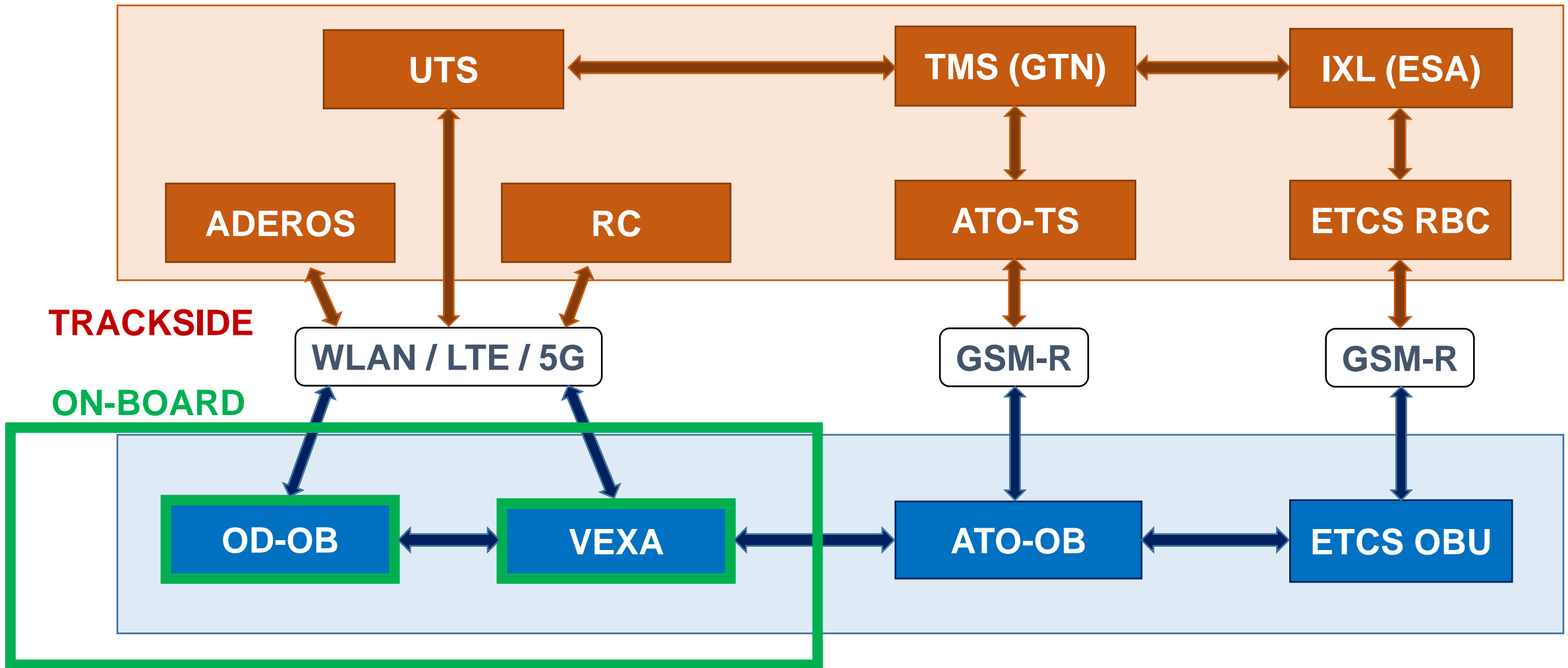
G O A	Grade of Automation	Train supervision	Train control	Supervision of area in front of train	Closing the door	Permission to depart from station
	GoA0	Train driver	Train driver	Train driver	Train driver	Train driver
	GoA1	System	Train driver	Train driver	Train driver	Train driver
	GoA2	System	System	Train driver	Train driver	Train driver
	GoA3	System	System	System	responsible operators	responsible operators
	GoA4	System	System	System	System	System

Responsibility: ■ System ■ Train driver/responsible operators

GoA3/4 system architecture (goal: complex system)



GoA3/4 system architecture (On-board systems)



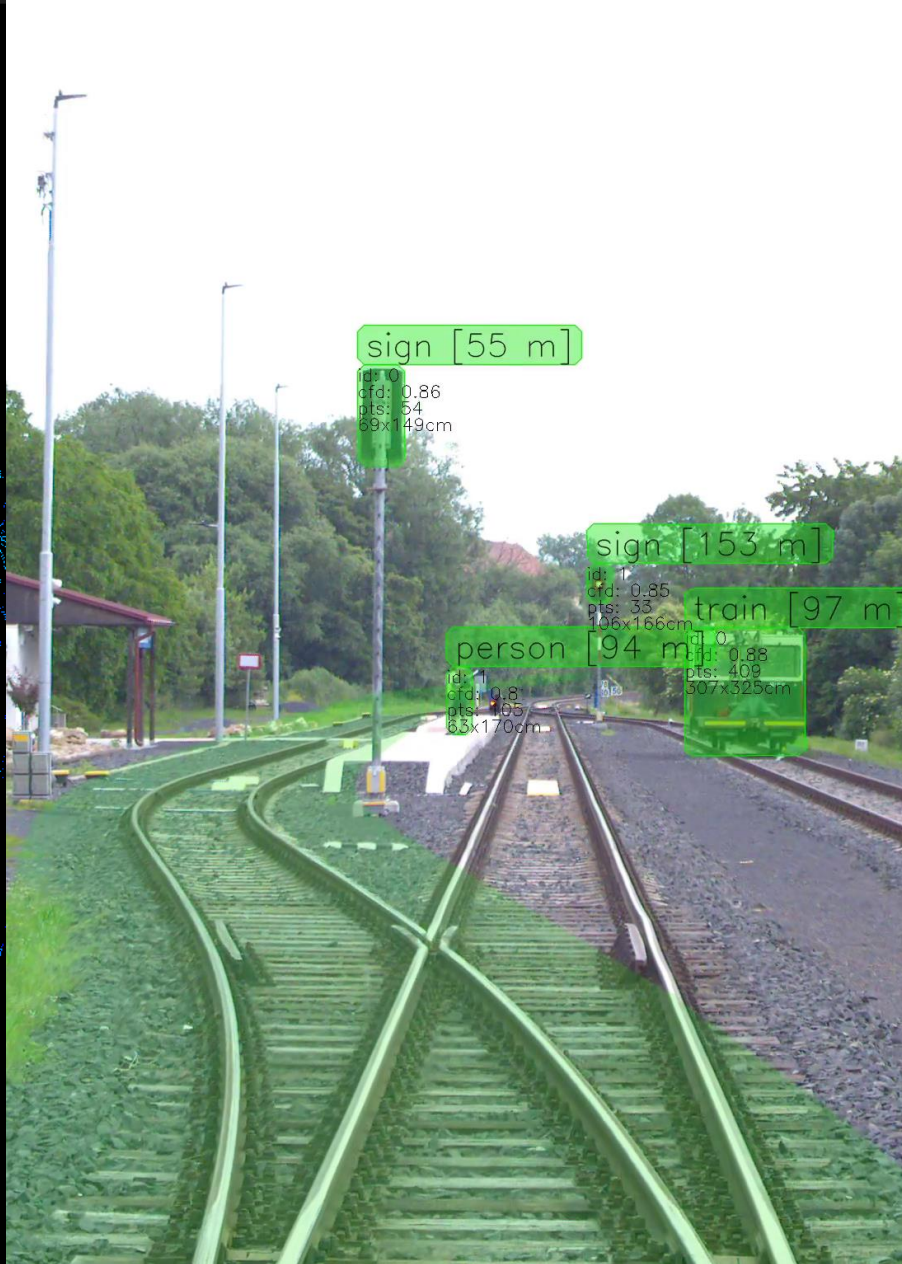
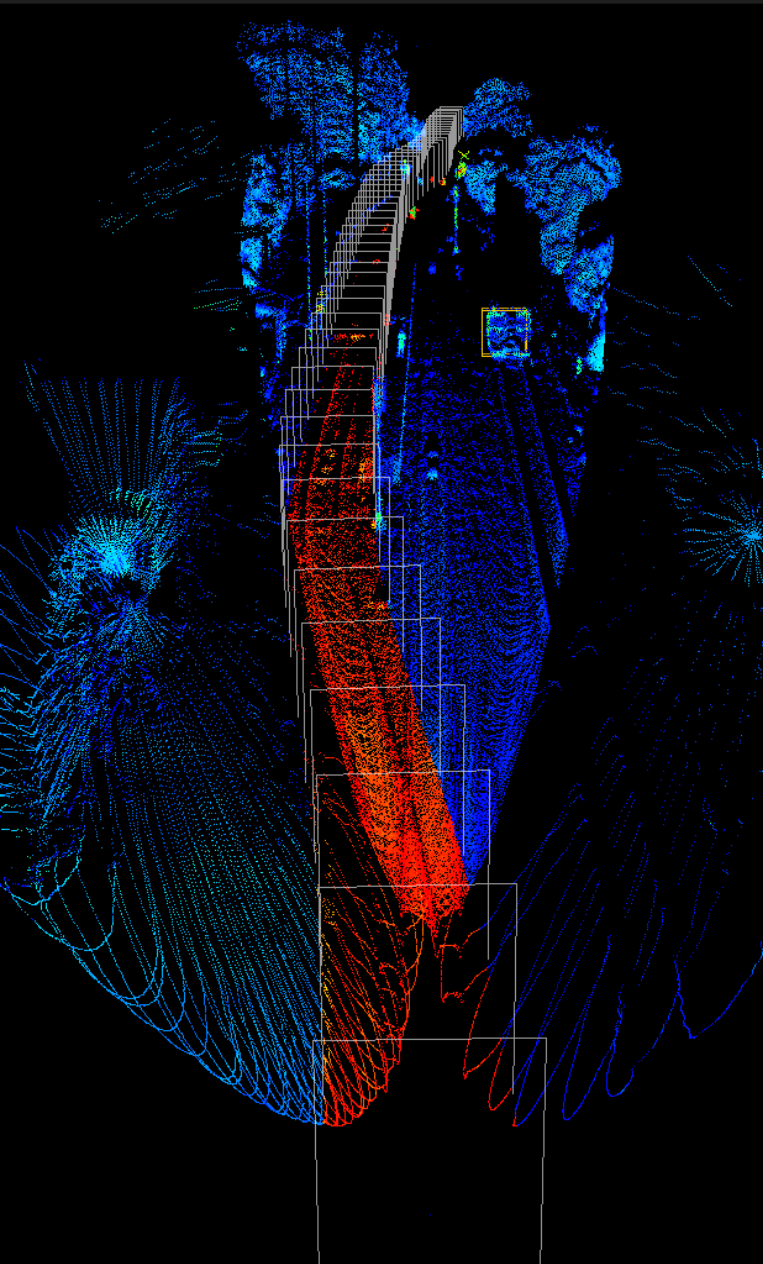
VEXA Expert decision system

- The train expert decision system replacing the driver's decision-making
 - All possible situations
- VEXA is able to:
 - Gather data from all systems, to process these data and make the right decision
 - E.g. react to detected obstacles, approve train departure, ...
- Different types of decision-making
 - Stack-based finite state machine / fuzzy logic-based model / AI based model
- Cooperation with Czech Technology University in Prague

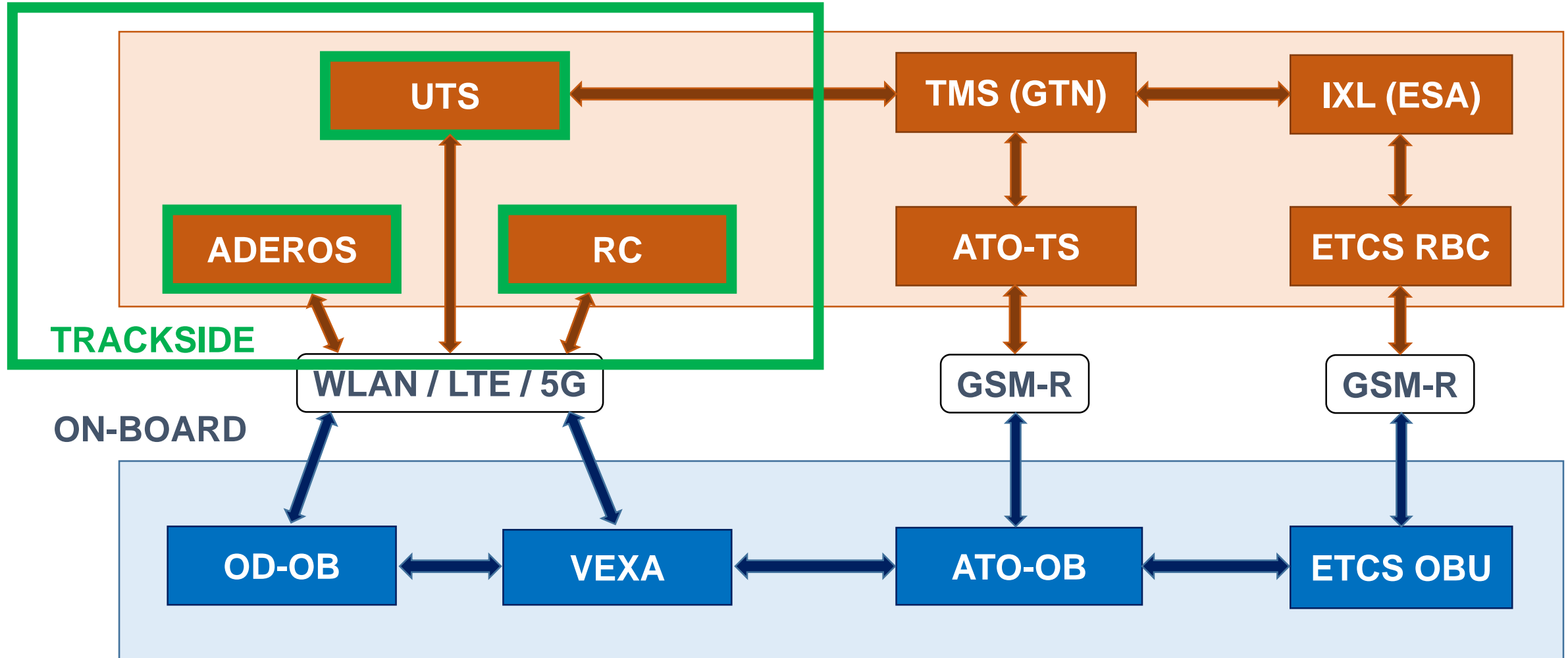
OD-OB Object Detector (on-board)

- „Replaces“ the driver's sight
- Many different sensors
 - Lidars, cameras,...
- OD-OB is able to:
 - Detect and classify objects
 - Analyse object attributes (sent to VEXA)
- 3D LIDAR point cloud, camera data
 - Machine learning, AI





GoA3/4 system architecture (Trackside systems)



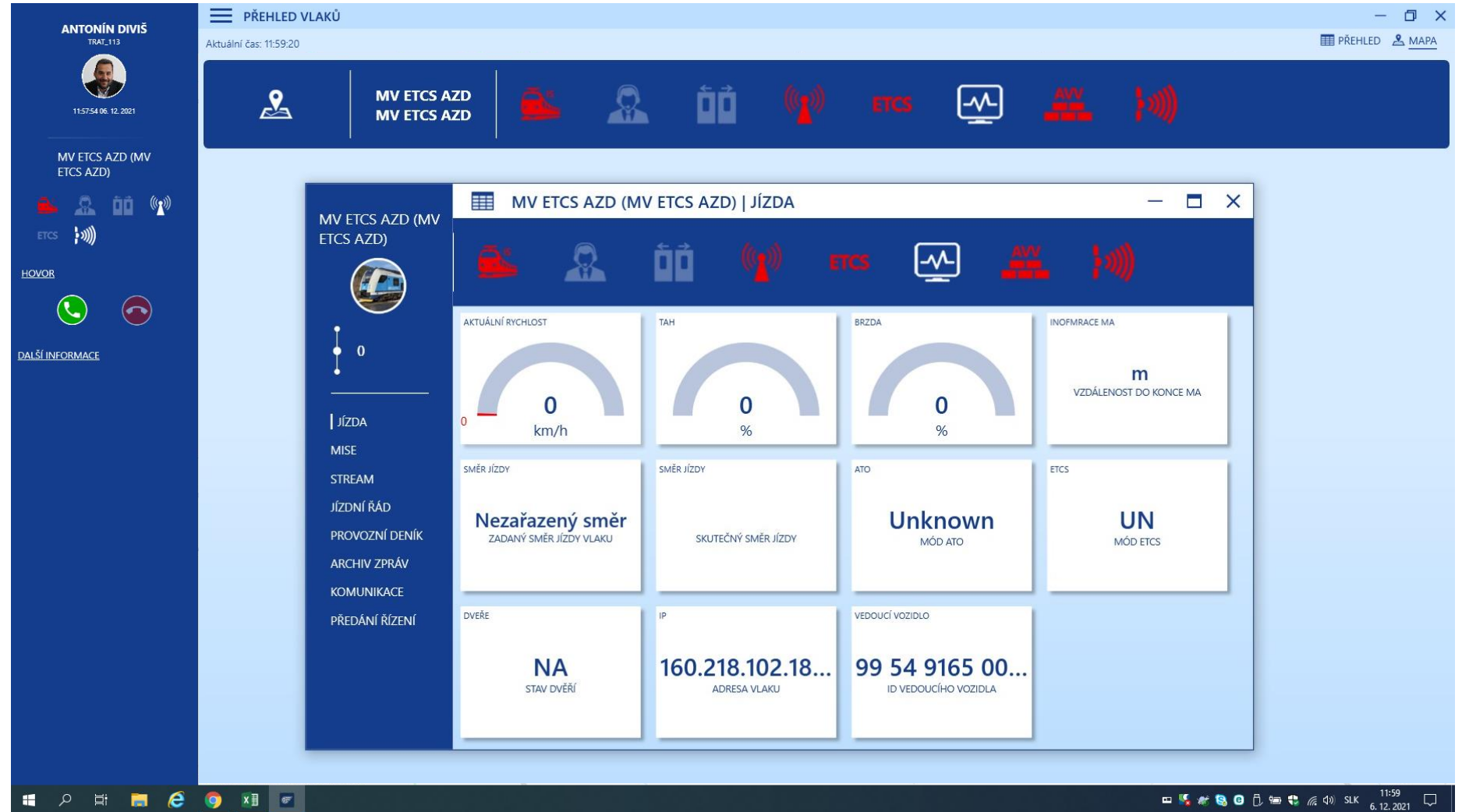
ADEROS Detection of risky situations in traffic

- Object / situation detection
 - LX, Platforms, Risky places
- Smart camera and server
 - Using AI
- Data stored on server
 - Potential risk info sent to autonomous train
- Cooperation with Brno University of Technology



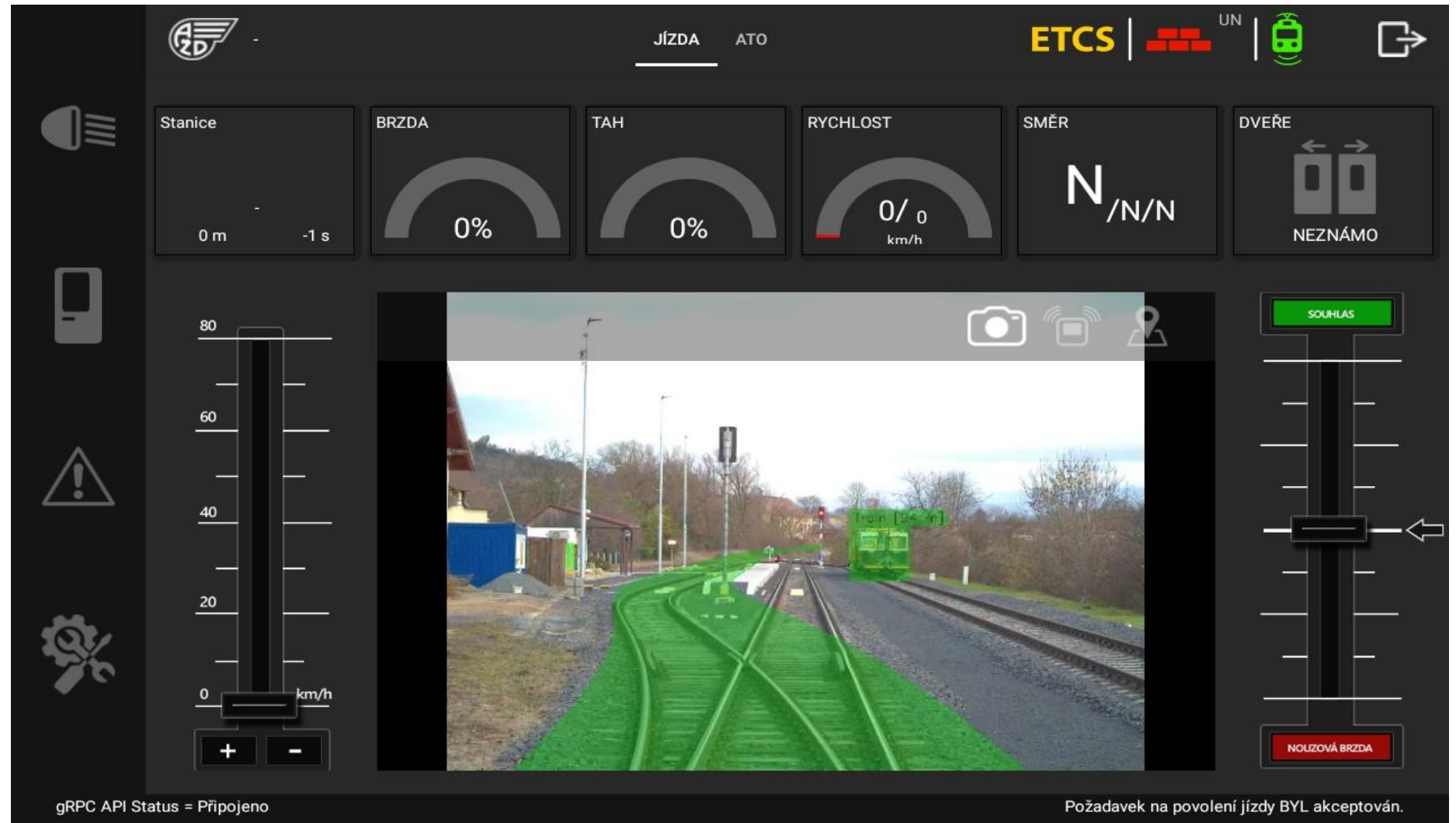
UTS Unattended Train Supervision terminal

- Desktop app
- Able to:
 - Info display
 - Vid-streams
- Unexpected situations handling
- VPN secured



RC Application for train remote control

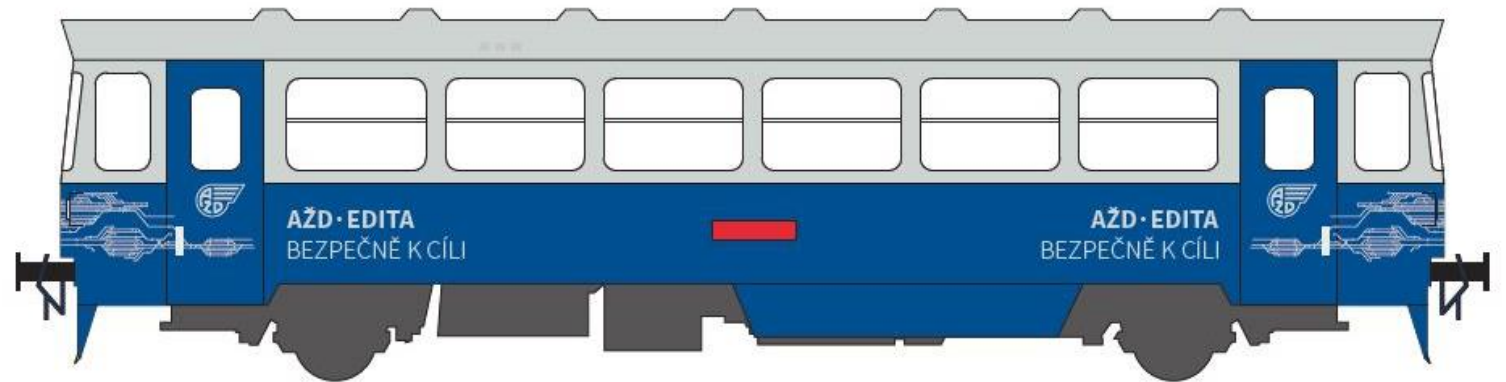
- Mobile app
- Info display
- GUI
- VPN secured



EDITA - „New” autonomous vehicle

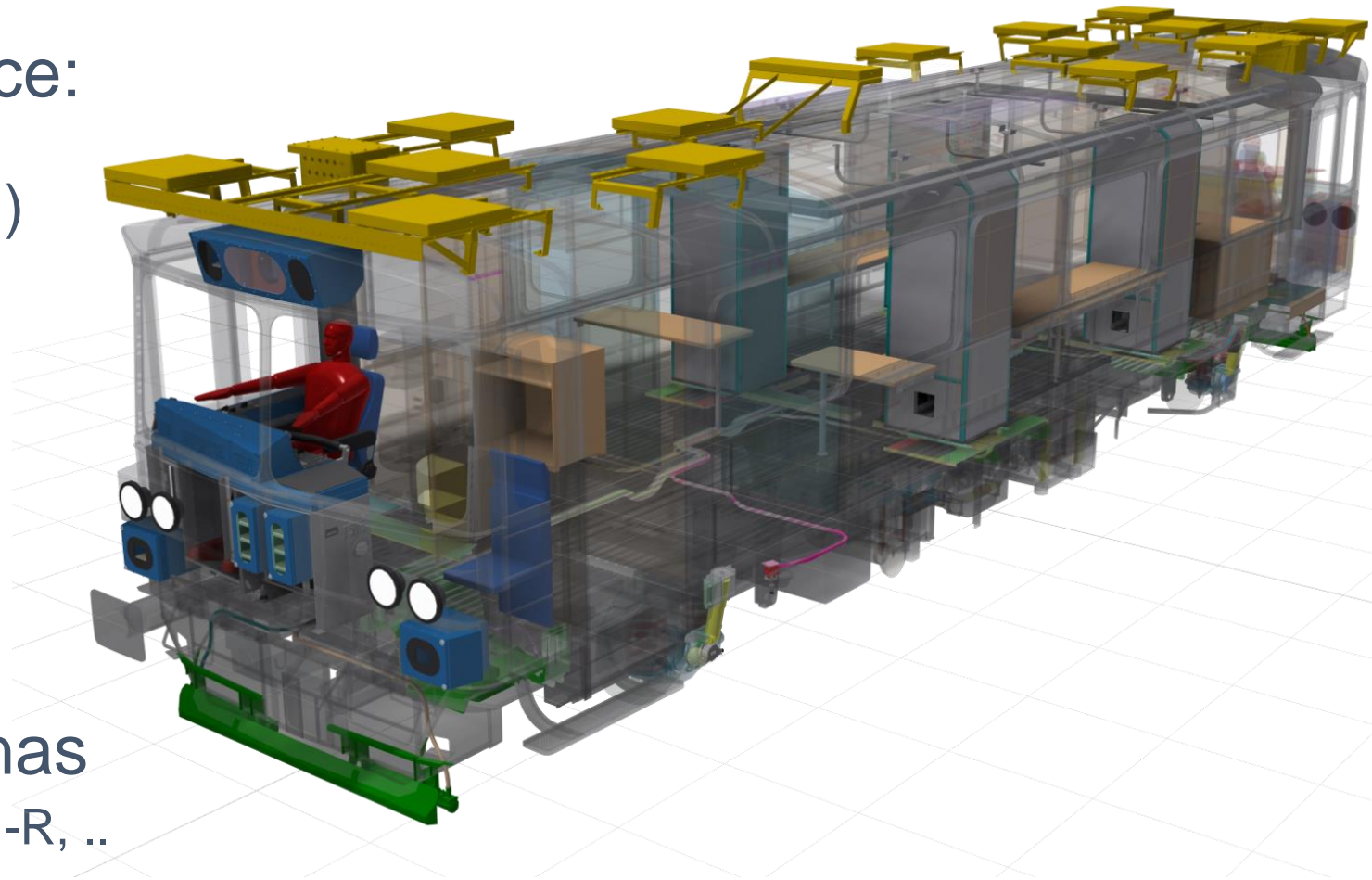
- For autonomous train operation and systems testing / demonstration
- 810 class vehicle with diesel engine
 - Fully modernized and equipped with technologies

Experimental
Driverless vehicle for
Innovative
Technologies of
AZD



EDITA - „New” autonomous vehicle

- Four 19-inch racks for device:
 - ETCS OBU (SS-130 for AoE)
 - ATO-OB and TCMS
 - GNSS save positioning
 - Expert decission module
 - Detectors – Object detector
 - With integrated sensors
- On the roof up to 15 antennas
 - 5G, LTE, WLAN, GNSS, GSM-R, ..



Path towards autonomous railways

- To continue testing of GoA3/4 subsystems on AZD vehicles and tracks
- To gather critical minimum mass of data from real environment
- To actively work with railway sector partners in Shift2Rail and Europe's Rail to define common standardised approaches.
 - GoA3/4 specifications and interfaces
 - Safety principles and certification procedures (e.g. for AI)
- **To operate fully standardised autonomous trains on AZD own tracks and elsewhere**

Thank you for your attention

Questions?

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