

Remote & Autonomous Driving for Shunting Operations

Autonomous Vehicle
CAF & NS Demonstrator

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CAF: Automated & Autonomous Vehicle Initiatives

Mainline Demonstrator (CAF & NS): ATO Automatic Shunting

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Automated & Autonomous Vehicle Initiatives @ CAF

Activities

Automated & Autonomous Vehicle - Activities

MAINLINE

- Automated Driving @ Mainline
- Autonomous Shunting Operations
 - Remote driving
 - Autonomous movements



TRAMWAY

- Automated Driving @ Commercial Service
- Autonomous Depot Operations
 - Remote driving
 - Autonomous movements



METRO

- Fully Autonomous Commercial Service



BUSES

- Autonomous Depot Operations
 - Autonomous movements



Automated & Autonomous Vehicle - Activities

MAINLINE

- Automated Driving @ Mainline
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TRAMWAY

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/ Mainline: Grade of Automation

Automation Level	Train Motion Initiated	Braking	Door Closing	During an Interruption	
GoA1	Driver	Driver	Driver	Driver	ATP: ETCS
Remote GoA1	Remote Driver	Remote Driver	Remote Driver	Remote Driver	Research
GoA2	Driver Automatic	Automatic	Driver	Driver	ATO: TS12023
Remote GoA2	Remote Driver Automatic	Automatic	Remote Driver	Remote Driver	Research
GoA3	Automatic	Automatic	Attendant Automatic	Attendant	
GoA4	Automatic	Automatic	Automatic	Automatic	Research



CAF & NS ATO Automatic Shunting

Demonstrator



/ Remote driving: GoA1 and ATO GoA2

- **Remote driving GoA1**
in depot & non-blocked mainline area,
up to 80km/h (day/night).
(Q4 2023)
- **Remote ATO GoA2 (TSI 2023)**
(Q1 2024)

VIDEO STREAMS:

*Far, short-medium, panto and
coupler views*



2D MAP

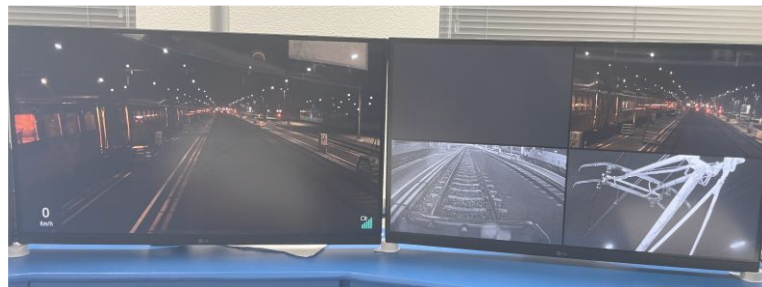
ATO DMI

ETCS DMI

*Horn, Wiper, Lights,
Pressure indicators...*

*SHUNTING
operation buttons*

During NIGHT



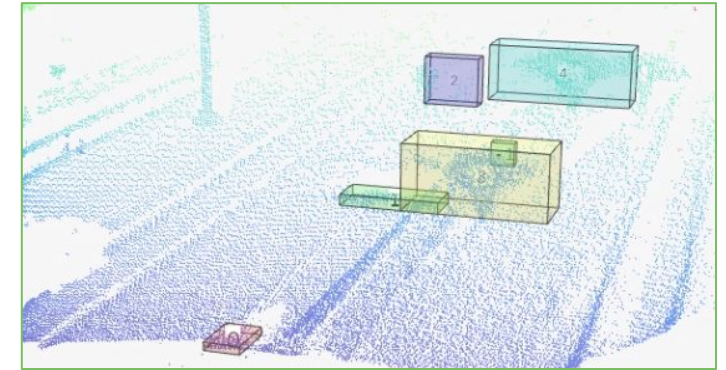
*DEADMAN
button*

*Cabin selector,
direction controller...*

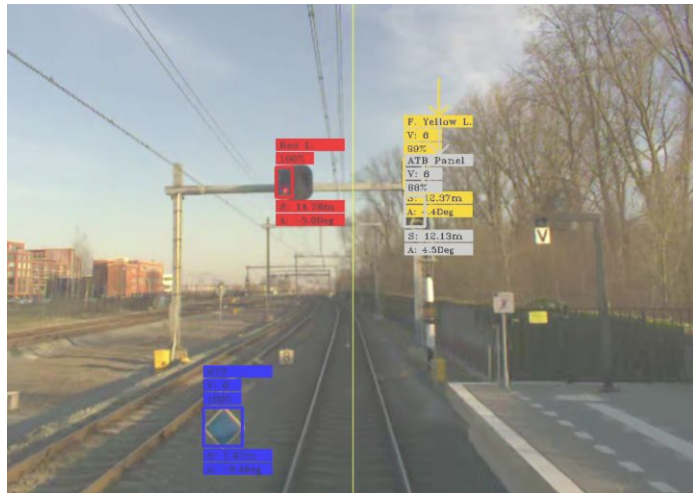
TCMS HMI

/ ATO GoA4 movements

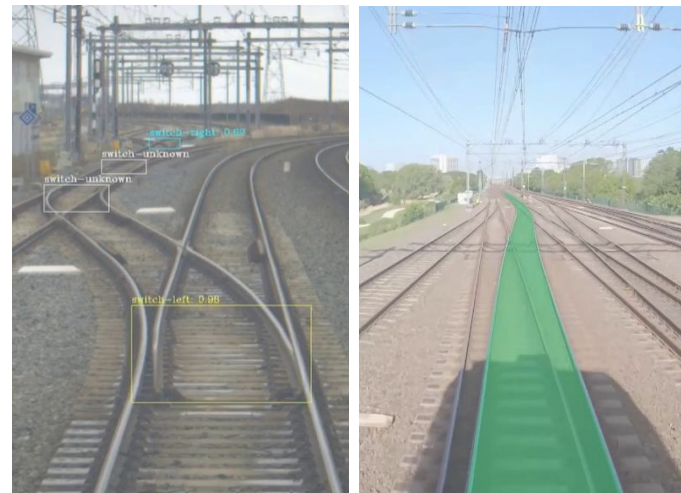
- Manage mission profile execution including journeys between depot & station and cabin changes.
- Operate driver actions for shunting operations: (de)coupling, washing and cleaning.
- Manage incidents and obstacle during mission execution.
- Fall-back to remote GoA1 driving when GoA4 driving condition are lost.
- Switch-off and put the train in stand-by mode.



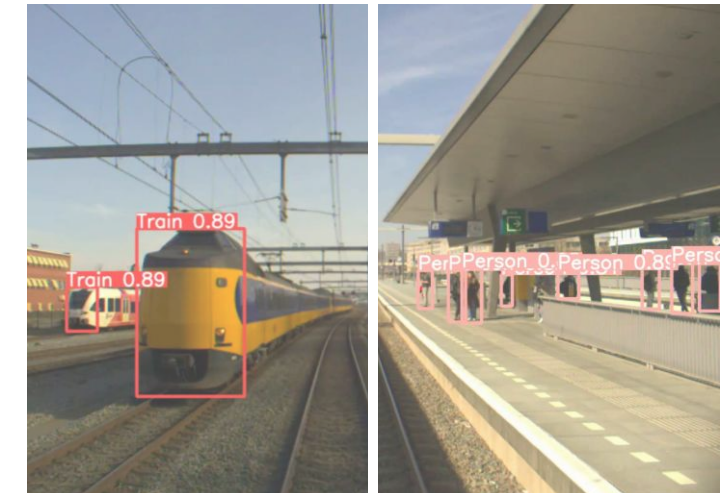
Signalling/Landmark detection



Train path monitoring



Obstacle detection

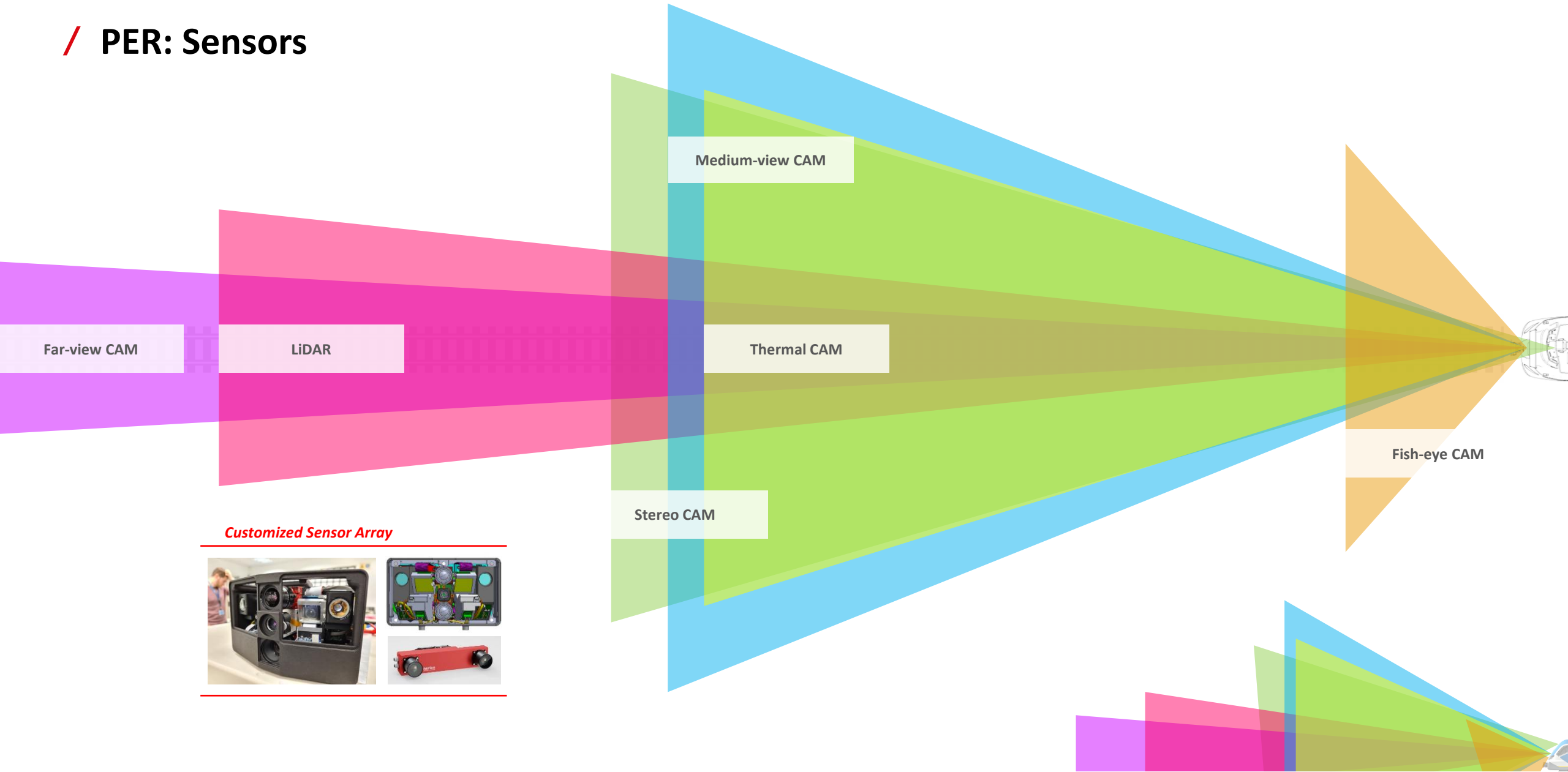


/ Alignment with EU-RAIL FA2 programme / R2DATO project

- Demonstrator – Tested Use Cases (WP38)
 - Remote Driving
 - D38.2 - Aligned with D5.4 (Remote Driving) definitions
 - Remote ATO - GoA2
 - D38.3 - Aligned with D5.1(ADM) and D5.4 (Remote Driving) definitions
 - GoA4 Movements
 - D38.4 - Aligned with D5.1 (ADM/APM) and D5.2 (PER) definitions
- Sub-system prototypes - Developed Functions (WP10,11 and 12):
 - Remote Driving
 - D12.2 - Remote Driving design description (Aligned with D6.7 requirements and specification definitions)
 - GoA4 Movements
 - D10.1 - ADM/APM design description (Aligned with D6.2 requirements and specification definitions)
 - D10.3 - ADM/APM test results (Aligned with D6.2 requirements and specification definitions)
 - D11.2 - PER design description and test results (Aligned with D6.3 requirements and specification definitions)



/ PER: Sensors



Far-view CAM

LiDAR

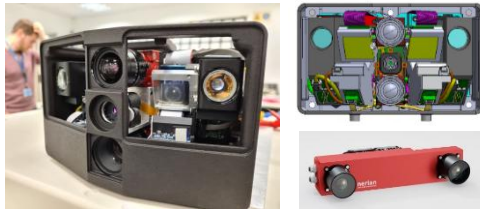
Medium-view CAM

Thermal CAM

Stereo CAM

Fish-eye CAM

Customized Sensor Array





99°

WC

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