Safe intervention: Traffic Management Systems & V2X

SESSION 6: Safe intervention

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Final Event

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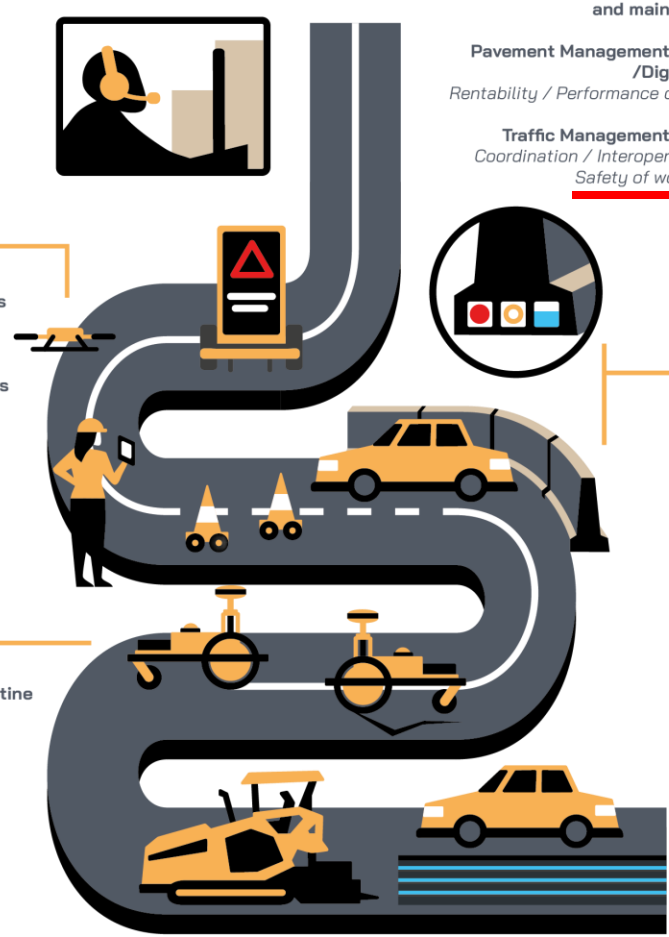
Technological areas and objectives

By focusing on the roadbed and, particularly, on roads paved with asphalt, InfraROB entails advancements across 5 strictly interrelated technological areas (TA).



TA5
Upgrading of Management Systems to ensure safer operations and maintenance

Pavement Management System /Digital twin
Rentability / Performance over time

Traffic Management System
Coordination / Interoperability / Safety of workzones

SOME KEY CONCEPTS

A **digital twin** is a virtual representation that serves as the real-time digital counterpart of a physical object or process.

Fiber Optic Sensors **(FOS)** embedded in the road pavement during construction enable long-term damage monitoring and detection.

Point location using **geo-referencing** methods allows accurate and safe navigation of the deployed robots.

Artificial intelligence (AI) applications control autonomous behaviour of equipment and achieve safer work zones.

TA4
Collaborative operation of safety cone robots and RPAS for work zone segmentation and signalling

Unsupervised monitoring of safety conditions

Alerting and signalling

TA3
Modularization of road construction/upgrade through industrial prefabrication

Multi-functional all-in-one precast concrete element
Safety barrier / Gutter and curb / Storm drain

TA2
Autonomous robotized machinery for the routine or periodic maintenance of the pavement

Potholes and cracks repair (3D printer)

Line-marking robot (cold paint)

TA1
Autonomous robotized machinery for construction, upgrade and large maintenance interventions

Road construction train
Feeder / Paver / Roller

Automated lay-down of FOS cables

Maintaining integrity, performance and safety of the road infrastructure through autonomous robotized solutions and modularization

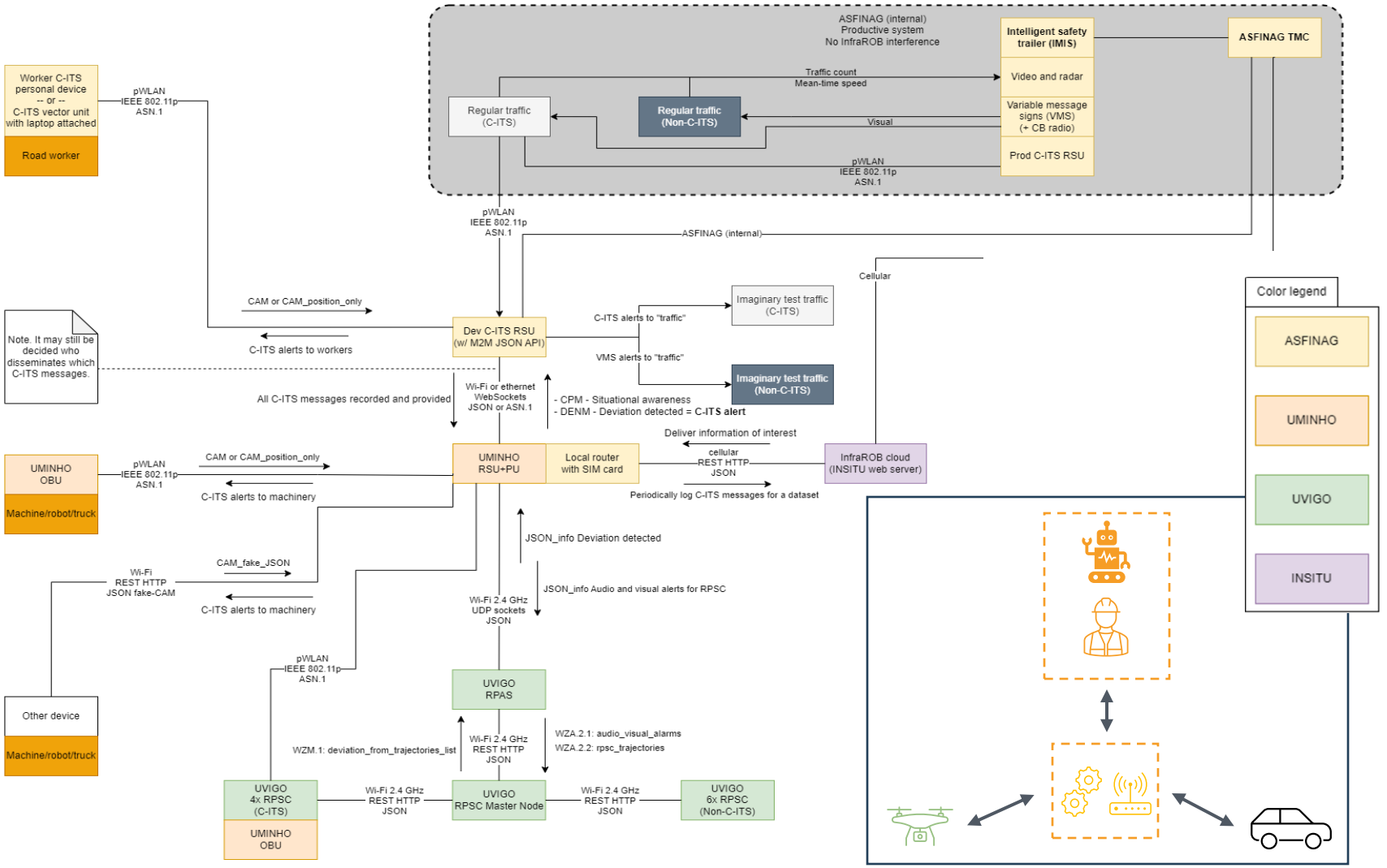
Technological Area 5 | Objective 8

TA5 Upgrading of management systems to ensure safer operations and maintenance

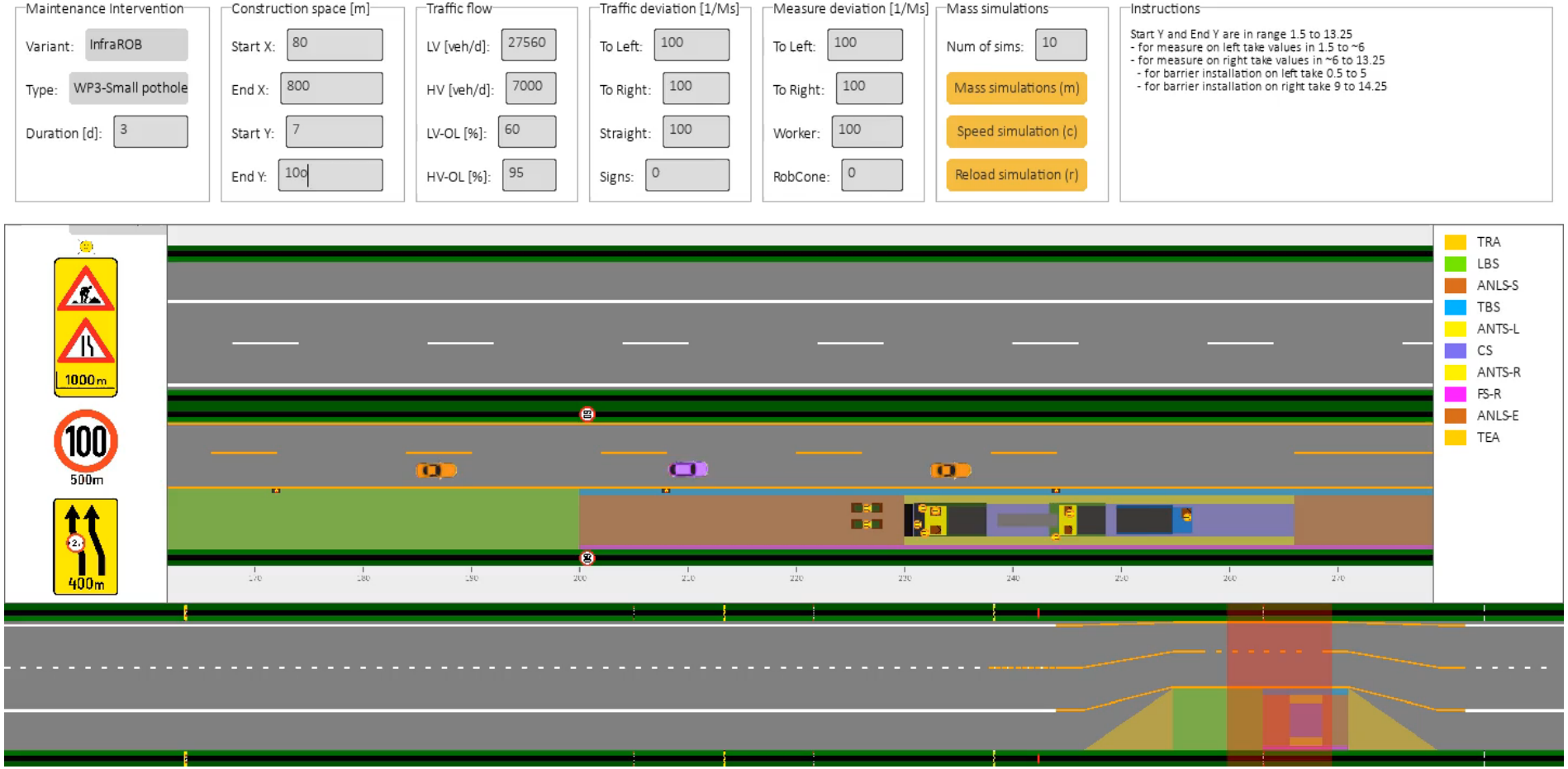
O8 Upgrade existing traffic management applications to account for the introduction of robotics in traditional pavement maintenance.

- Develop methodology and tools to incorporate robots and autonomous machines in the framework of C-ITS and traffic management.
- Track location of maintenance robots and machines on the road in real-time.
- Assess the possibility to improve safety of robotic work zones with warning and alerting systems and develop traffic coordination models.
- Perform agent-based road work zone and traffic simulations for initial assessment.
- Implement C-ITS solutions for warning and alerting both road users and road workers during the road maintenance work to improve safety.

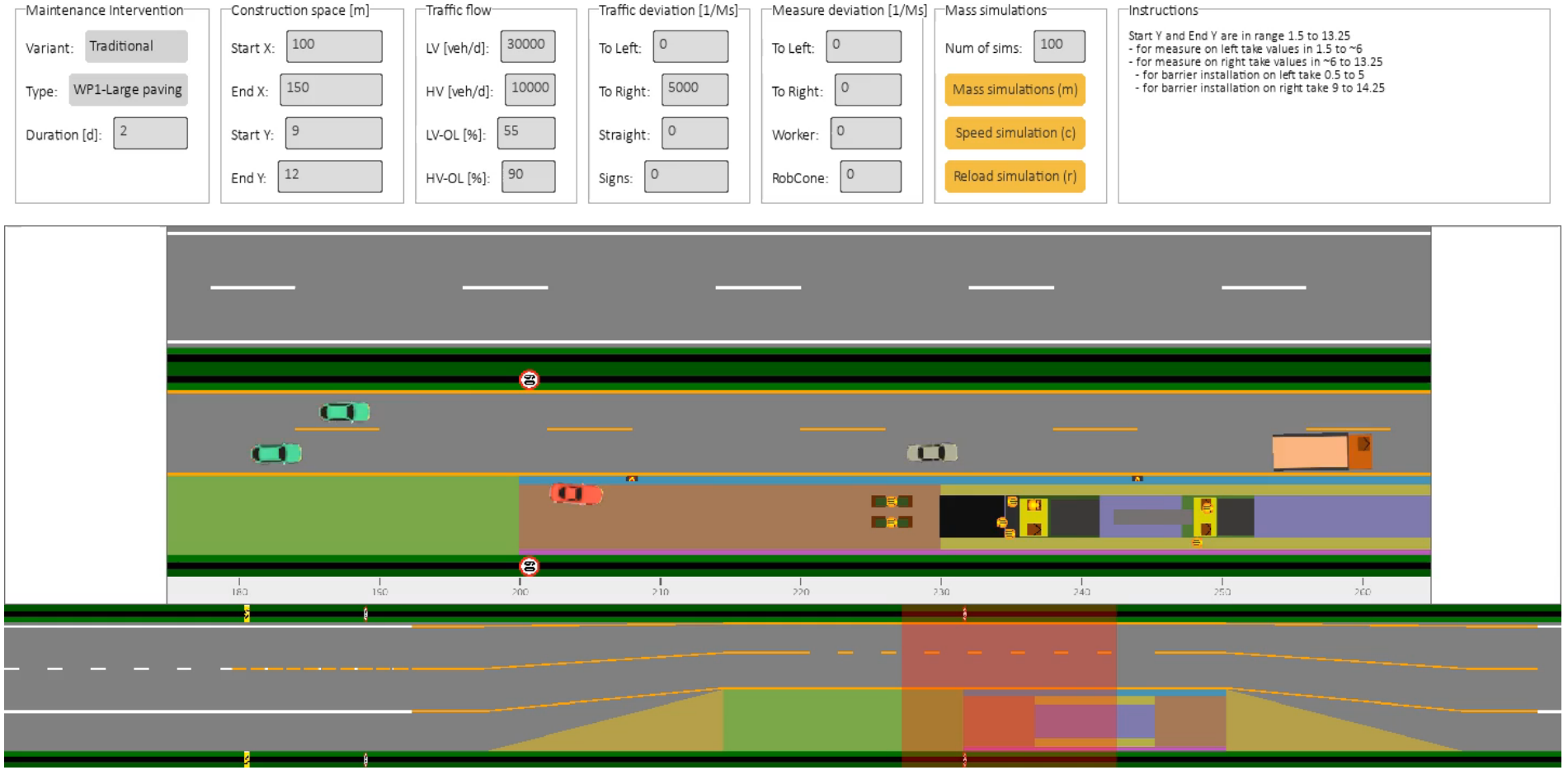
Safety analysis and traffic coordination model



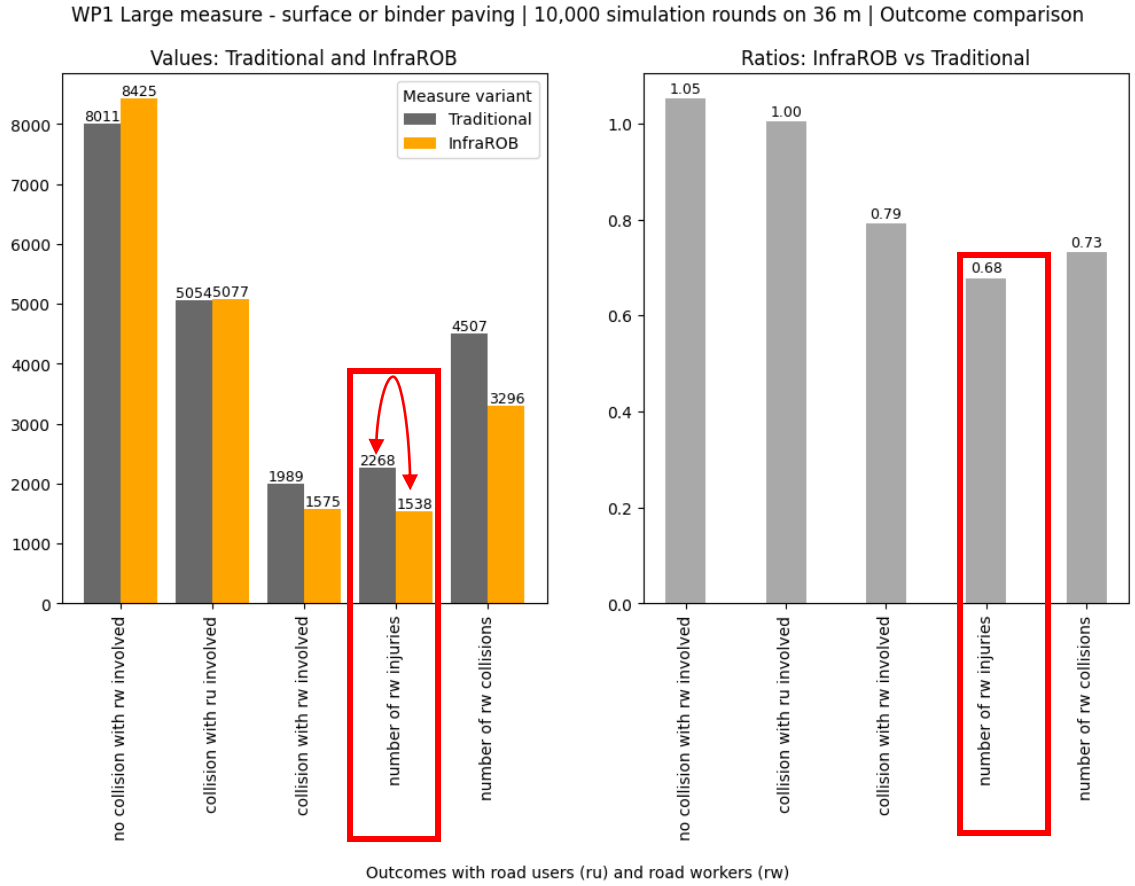
Agent-based road work zone safety simulation
Setup and simulation parameters



Agent-based road work zone safety simulation
Collisions between road users and road workers

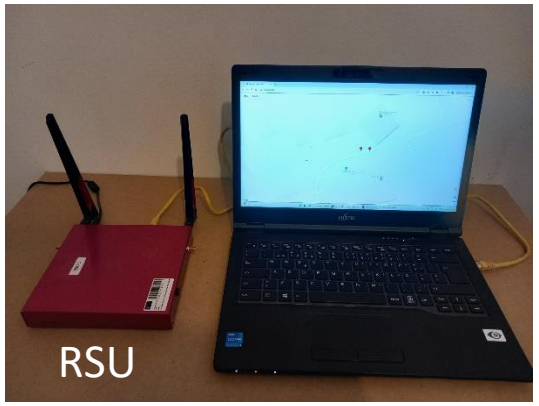


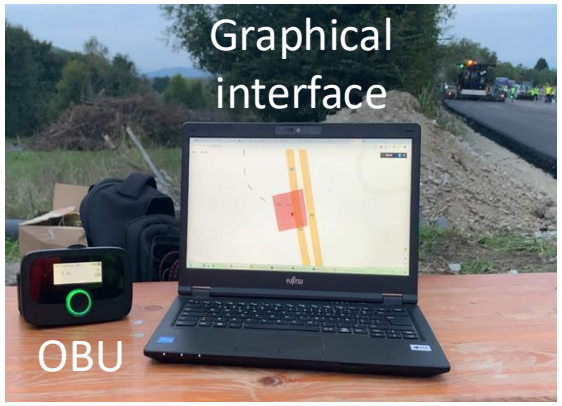
Simulated accident statistic
Compare InfraROB and traditional measure variants

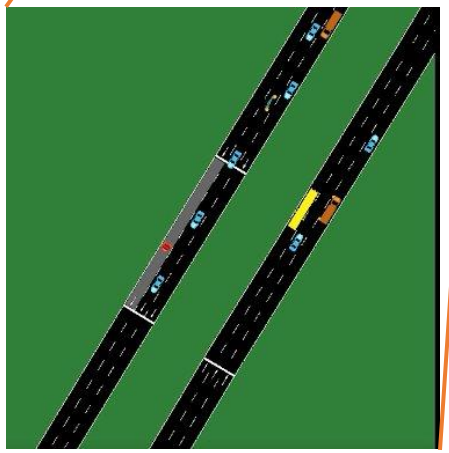


Traffic simulation with V2X communication for the coordination of robots and road users

- Traffic simulation for V2X development.
- Multiple simulation scenarios to specify parameters for V2X system design.
- Acquired and prepared V2X devices.
- Developed V2X applications for devices.
- Established graphical interface for alerting.

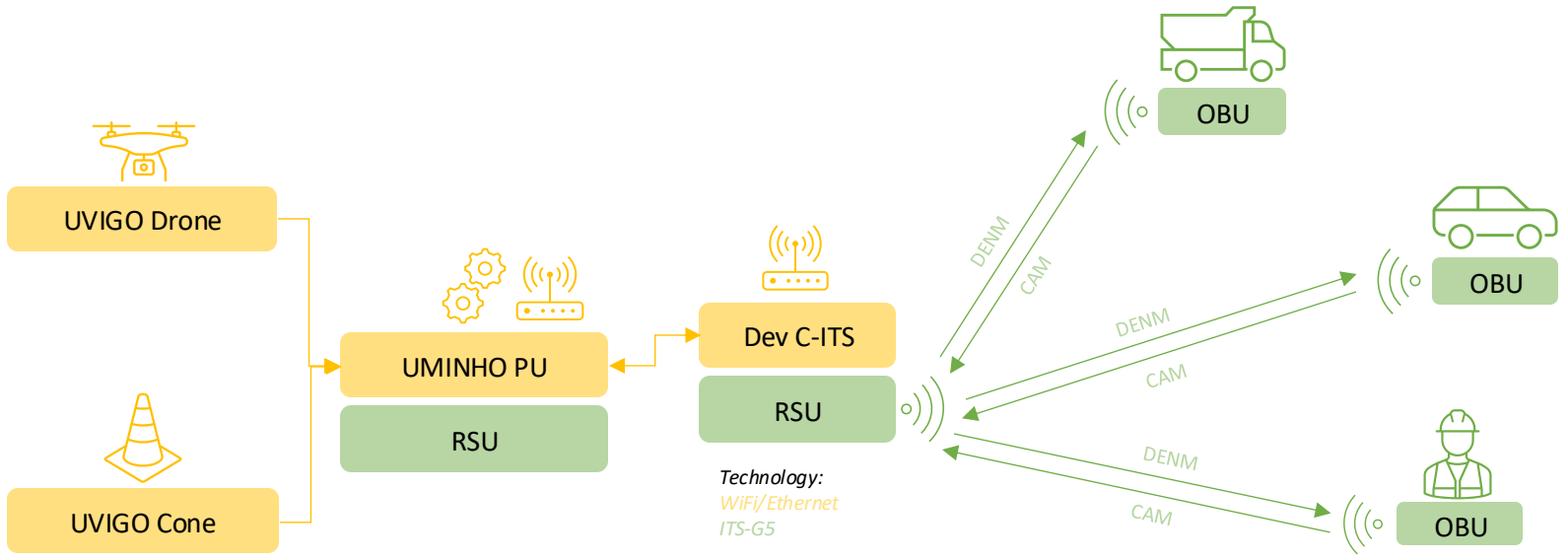






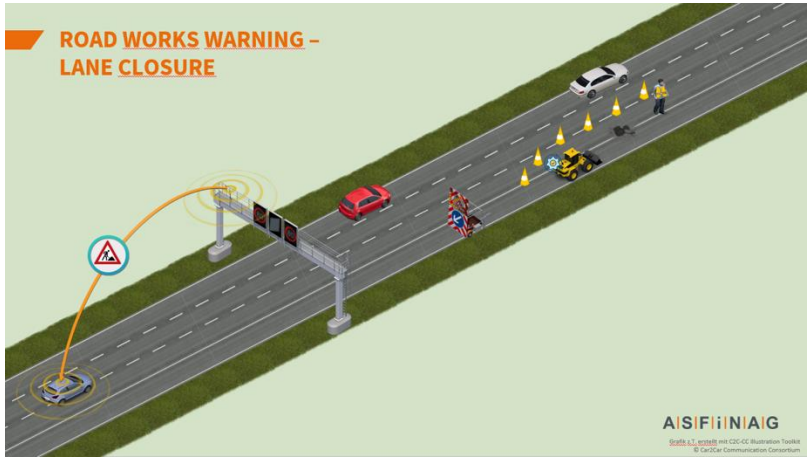
Overview of V2X communications for the safety of work zones

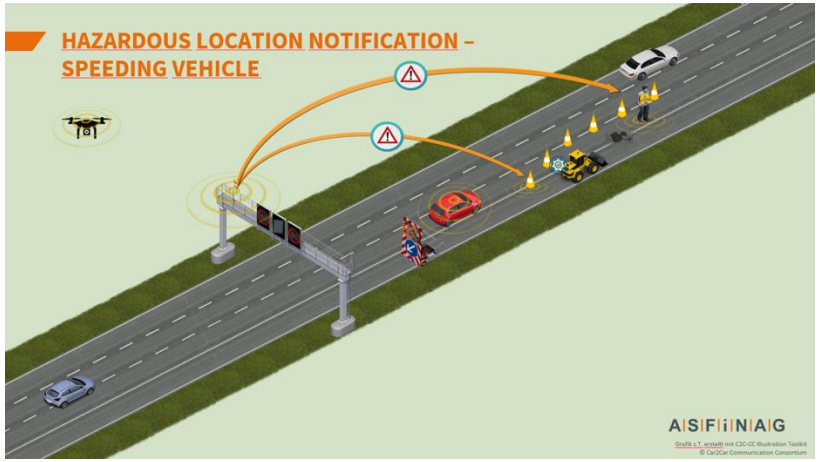
- Communication between road workers and road users.
- Track road workers and road users and detect deviations and dangers.
- Alert through C-ITS, personal devices and graphical interface.
- Use V2X communications to increase the safety of work zones.

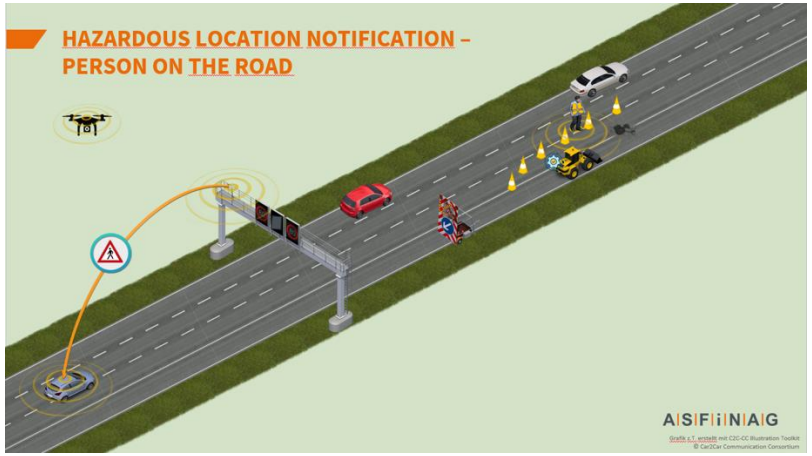


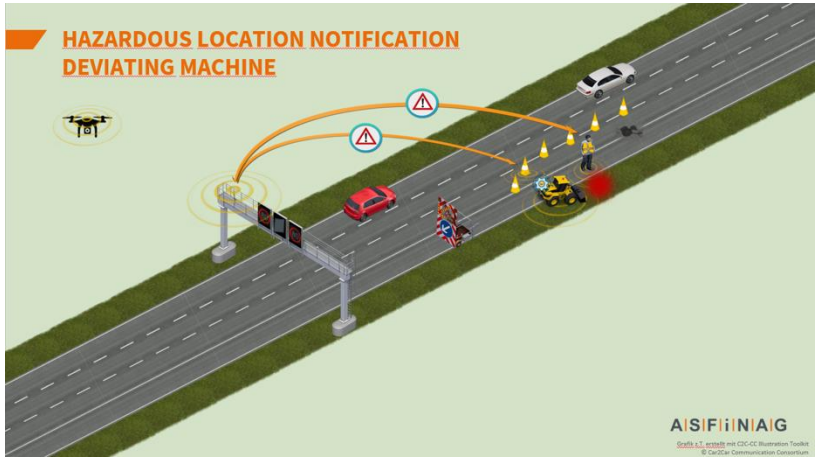
Safety of work zones – How can C-ITS help?

InfraROB C-ITS Use Cases
for enhancing the safety of automated work zones



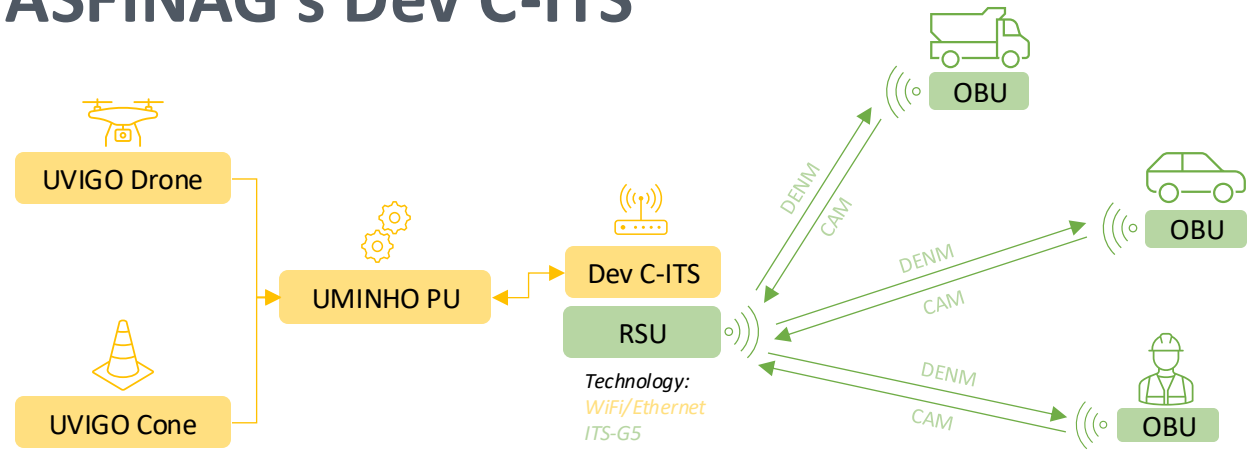






Demonstration of C-ITS Warning User Services in Spielfeld, Austria

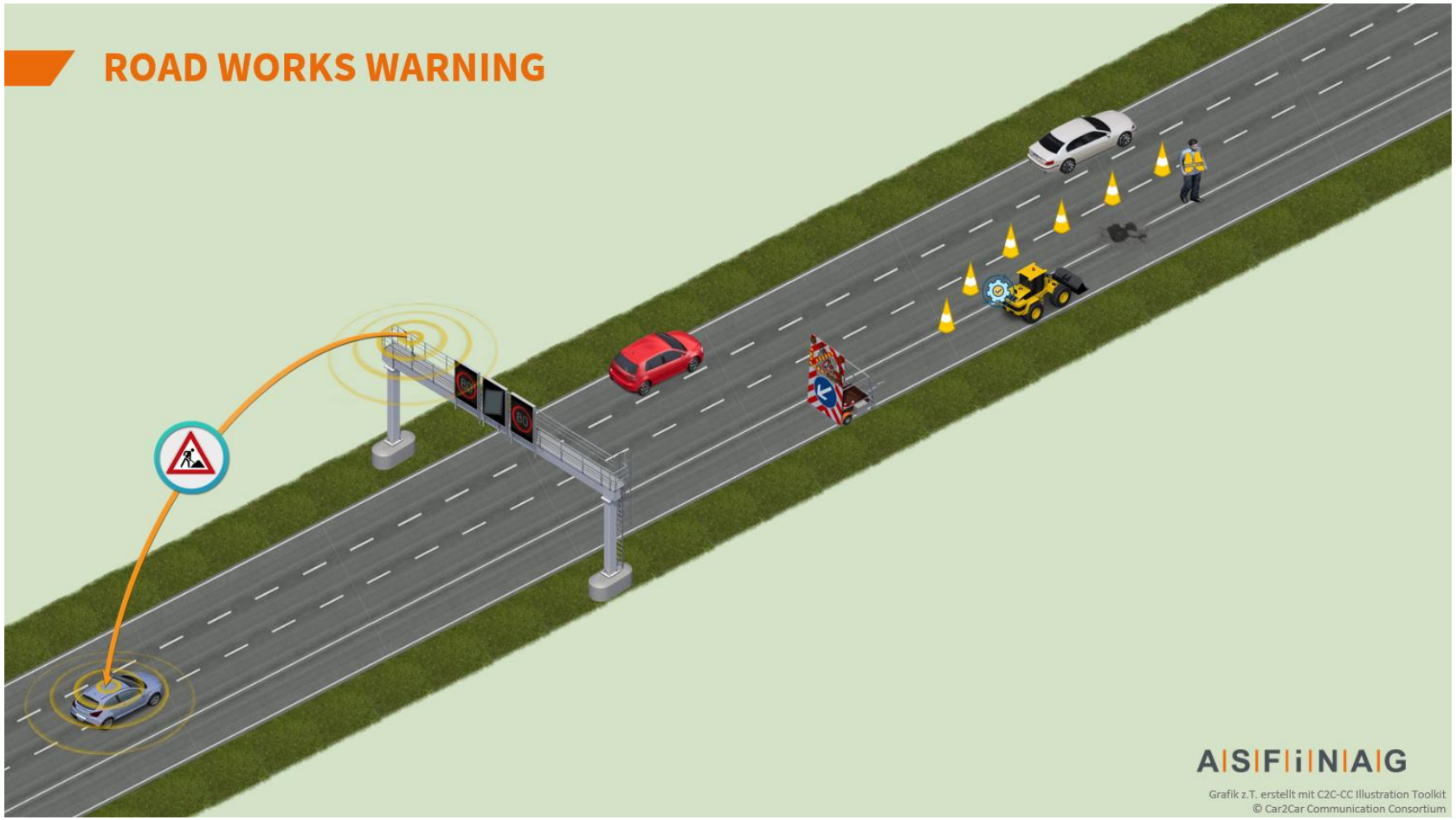
ASFINAG's Dev C-ITS



Test equipment

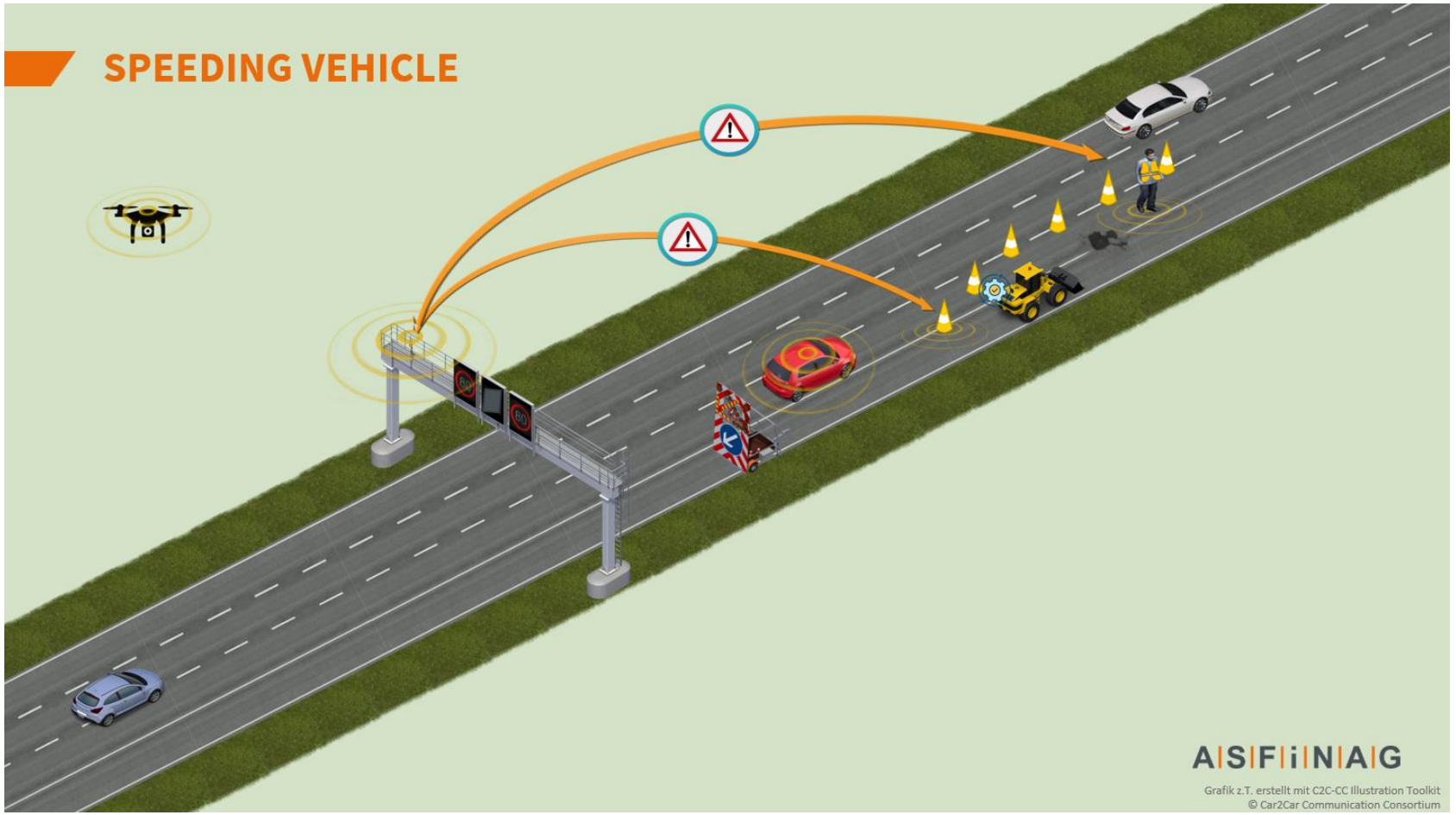
Installations in Spielfeld

Use Case A
Road Works Warning



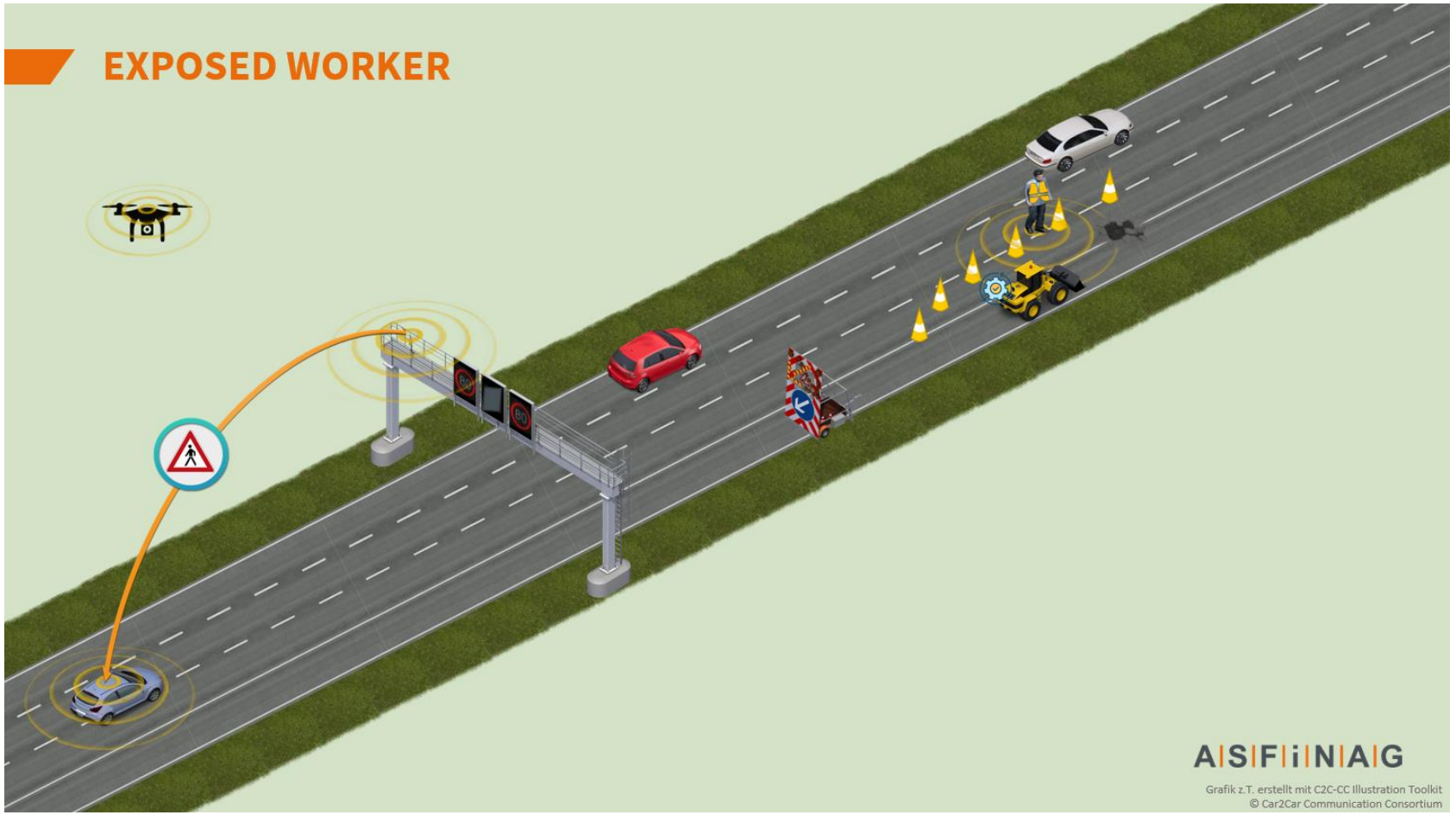
Use Case A
Road Works Warning

Use Case B
Speeding Vehicle



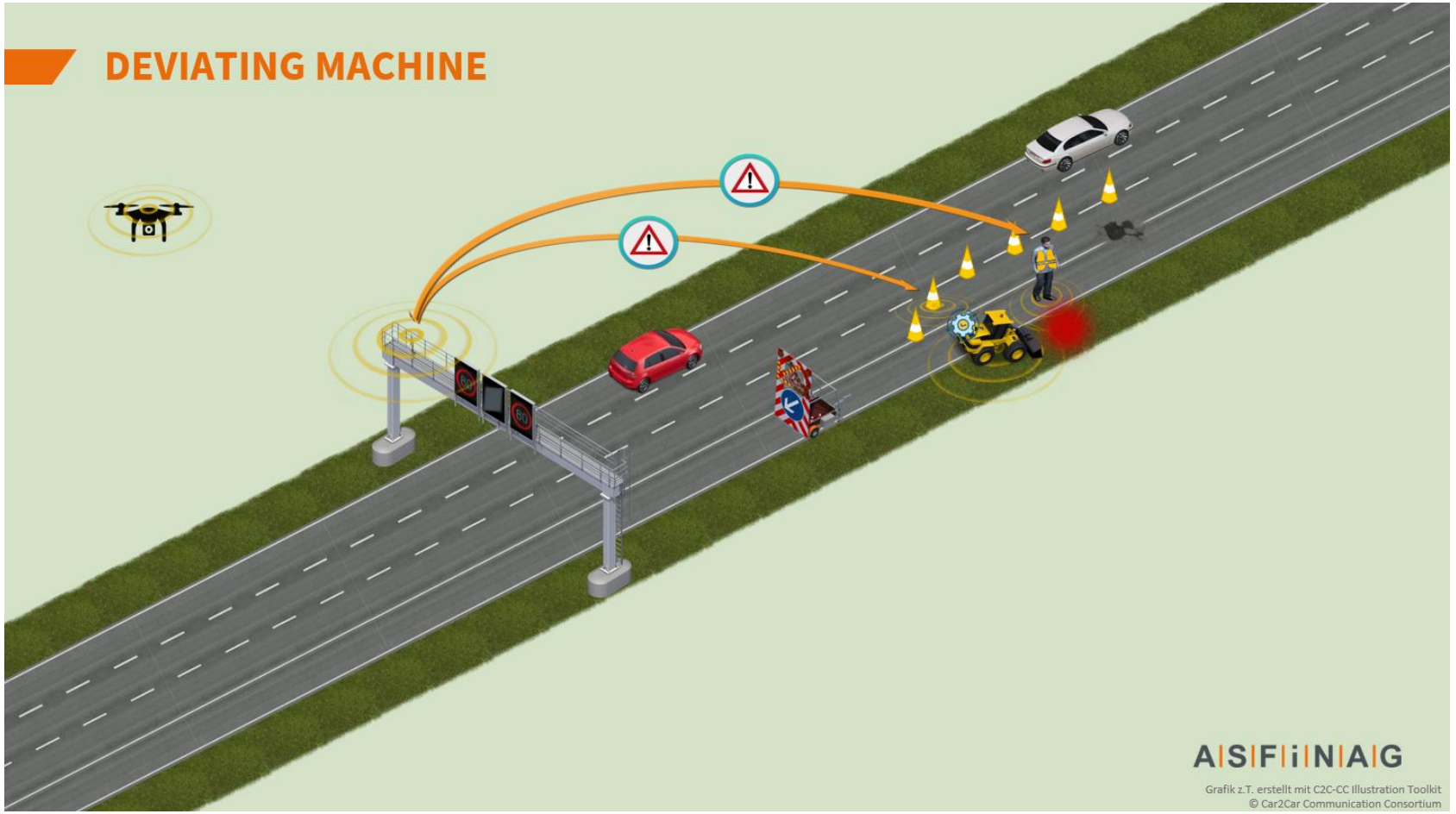
Use Case B
Speeding Vehicle

Use Case C
Exposed Worker



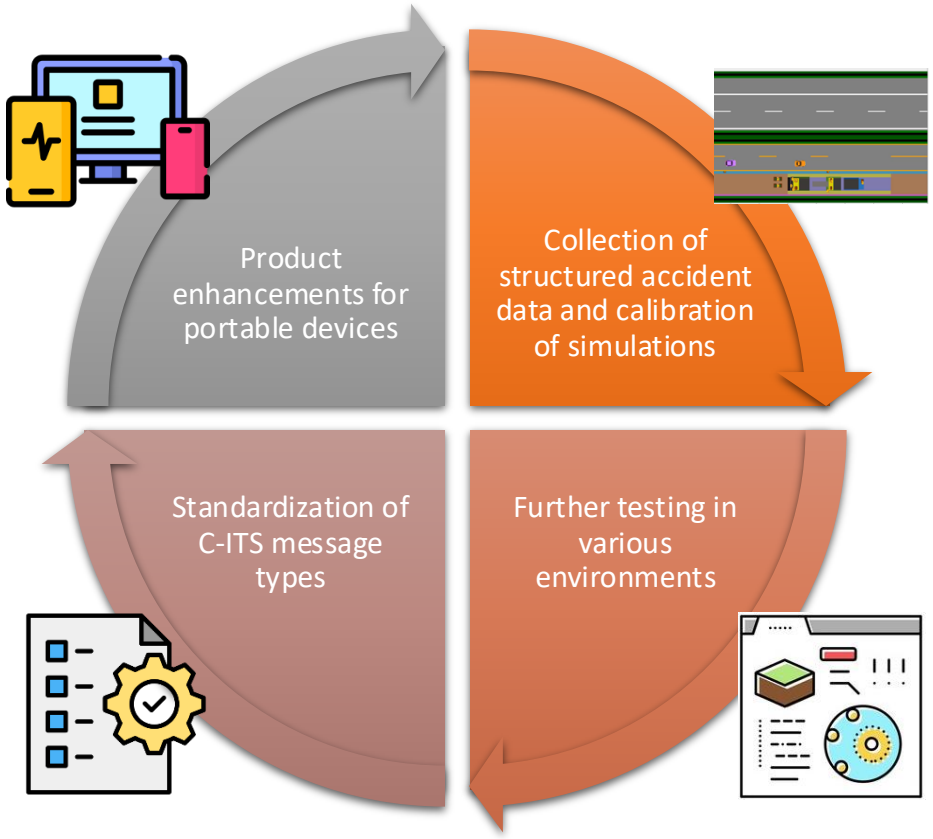
Use Case C
Exposed Worker

Use Case D
Deviating Machine



Use Case D
Deviating Machine

Next Steps


Product enhancements for portable devices
Collection of structured accident data and calibration of simulations
Further testing in various environments
Standardization of C-ITS message types

Thank you for your attention

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Infra ROB

Maintaining integrity, performance and safety of the road infrastructure through autonomous robotized solutions and modularization

Project Partners

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Backup slides

InfraROB C-ITS Warning User Services
for enhancing the safety of automated work zones

Use case	Road Works Warning	Speeding Vehicle	Exposed Worker	Deviating Machine
Description	Road works ahead	Approaching vehicle with critical speed and/or direction	Worker too close to live traffic	Paver and/or feeder out of defined area
Perception	N/A	Drone		
Additional position information	N/A	Approaching Vehicle (via CAMs, if C-ITS equipped)	Worker with portable C-ITS device (via CAMs)	Machines, C-ITS Safety Cones
Sender	C-ITS Roadside Unit			
Receiver	Approaching vehicle (C-ITS equipped)	• Exposed worker (with portable C-ITS device) -> Display message and beep • C-ITS Safety Cones -> Flashlight	Approaching vehicle (C-ITS equipped)	• Exposed worker (with portable C-ITS device) -> Display message and beep • C-ITS Safety Cones -> Flashlight
C-ITS warning user service	DENM Road Works Warning (C-ROADS Message Profile)	DENM HLN – Vehicle work zone intrusion (InfraROB-0) **-> newly developed**	DENM HLN – Person on the road (C-ROADS Message Profile)	DENM HLN – Deviation from pre-defined trajectory (InfraROB-4) **-> newly developed**

CAM – Cooperative Awareness Message | DENM – Decentralized Environmental Notification Message | HLN – Hazardous Location Notification