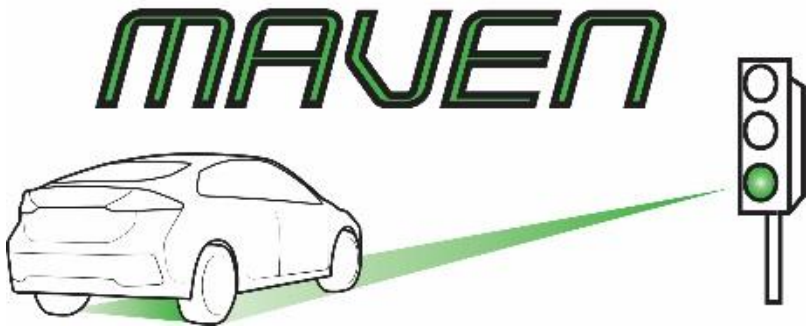


Julian Schindler

DLR

This project has received funding from the European Union's Horizon 2020 research and innovation programme

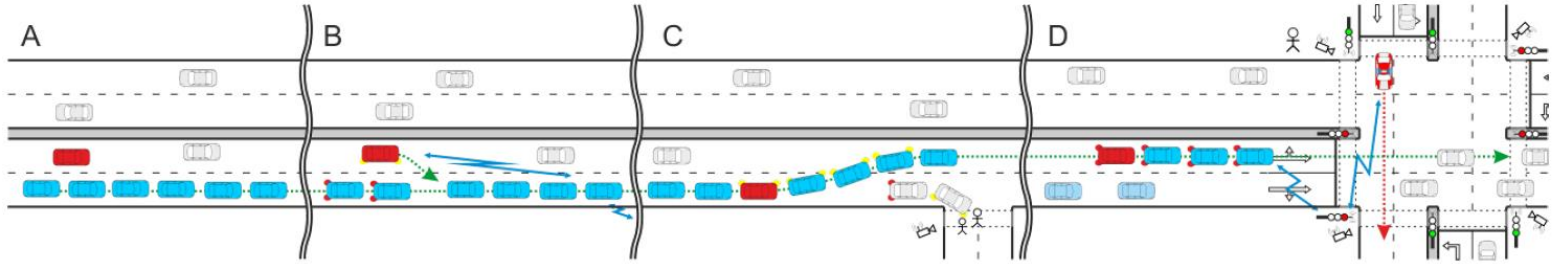
MAVEN
« Managing Automated Vehicles Enhances Network »

European H2020-MG-2014-2015 project

- MG-3.6a-2015 - Safe and connected automation in road transport
- Period: 01-09-2016 ~ 31-08-2019
- Budget: € 3.149.661,-

Focus:

- Platooning on arterial roads in urban areas
  - →maximises throughput and efficiency of urban road networks.
  - →Esp. at signalized intersections
- Hierarchical Traffic Management
- Traffic light phases negotiated with the demands of the traffic participants (e.g. platoons)



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Objectives

1) Develop a **generic multi-level system** for the **guidance of highly automated vehicles**, applied to dynamic platoons at signalized intersections and signalized corridors.

2) Contribute to the **development of C-ITS communication standards,** in particular message sets for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) interactions to support vehicle platooning and negotiation and scheduling algorithms.

3) Develop and integrate **ADAS techniques to prevent and/or mitigate dangerous situations** taking into account Vulnerable Road Users (VRUs, e.g. pedestrians and/or cyclists).

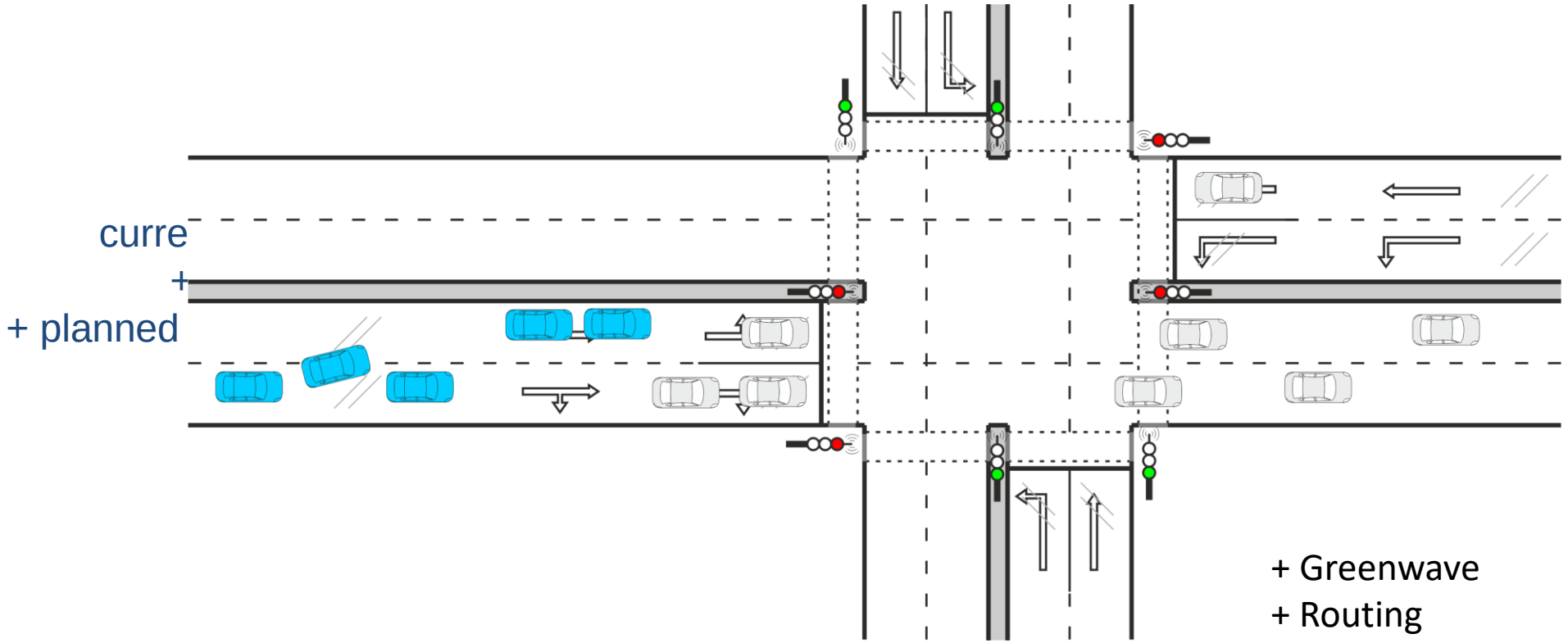
4) D**evelop, test, demonstrate and evaluate the MAVEN system** for signalized intersections and signalized corridors.

5) Produce a **roadmap** for the introduction of MAVEN-type systems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme

Objective #1:

Development of a generic multi-level system for the guidance of highly automated vehicles.



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Objective #2:
Contribution to the development of C-ITS communication standards

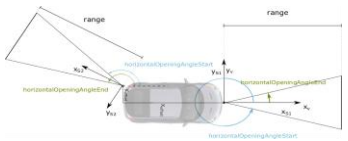
- **Backward compatible extension of CAM message (on Day1 SCH0)**
  - For I2V interaction (explicit probing)
    - ✓ Includes info needed by TLC (platoon/vehicles intentions + features)
    - ✓ Includes feedbacks on advices compliance
  - For platooning initialization
    - ✓ carries info for CAVs to detect opportunities for building/joining a platoon (e.g. Based on same expected route, desired speed, etc)

Ext CAM on SCH0		
ItsPduHeader (as in [ETSI EN 302 637-2])		
CoopAwareness	GenerationDeltaTime (as in [ETSI EN 302 637-2])	
	CAMParameters	BasicContainer (as in [ETSI EN 302 637-2], includes car position)
		HighFrequency Container = BasicVehicleContainerHighFrequency (as in [ETSI EN 302 637-2], includes dynamic info)
		LowFrequencyContainer = BasicVehicleContainerLowFrequency (as in [ETSI EN 302 637-2])
		SpecialVehicleContainer = MavenAutomatedVehicleContainer

- **Shorter CAM tx on a parallel SCH with higher frequency [10-30Hz]**
  - For platoon control (e.g. Planned path, position, speed, acceleration, heading)
  - For platoon management (e.g. joining, brake-up, termination flags)

Ext CAM on SCHx		
ItsPduHeader (as in [ETSI EN 302 637-2])		
CoopAwareness	GenerationDeltaTime (as in [ETSI EN 302 637-2])	
	CAMParameters	BasicContainer (as in [ETSI EN 302 637-2], includes car position)
		HighFrequency Container = AutomatedVehicleContainerHighFrequency
		LowFrequencyContainer = AutomatedVehicleContainerLowFrequency

- **SPAT and MAP extensions**
  - Lane Specific GLOSA
- **Collective Perception Message**
  - Vehicles and infrastructure share sensor and detected object data



CPM		
ItsPduHeader (as in [ETSI EN 102 894-2])		
CollectivePerception	GenerationDeltaTime (as in [ETSI EN 302 637-2])	
	CPMParameters	OriginatingStationContainer
		SensorInformationContainer
		PerceivedObjectContainer

- **Lane Advice Message**
  - Vehicles get individual lane advice information

MAVEN LAWEM	
ItsPduHeader (as in [ETSI EN 302 637-2])	
LAM	TimeInfo
	LaneAdviceList

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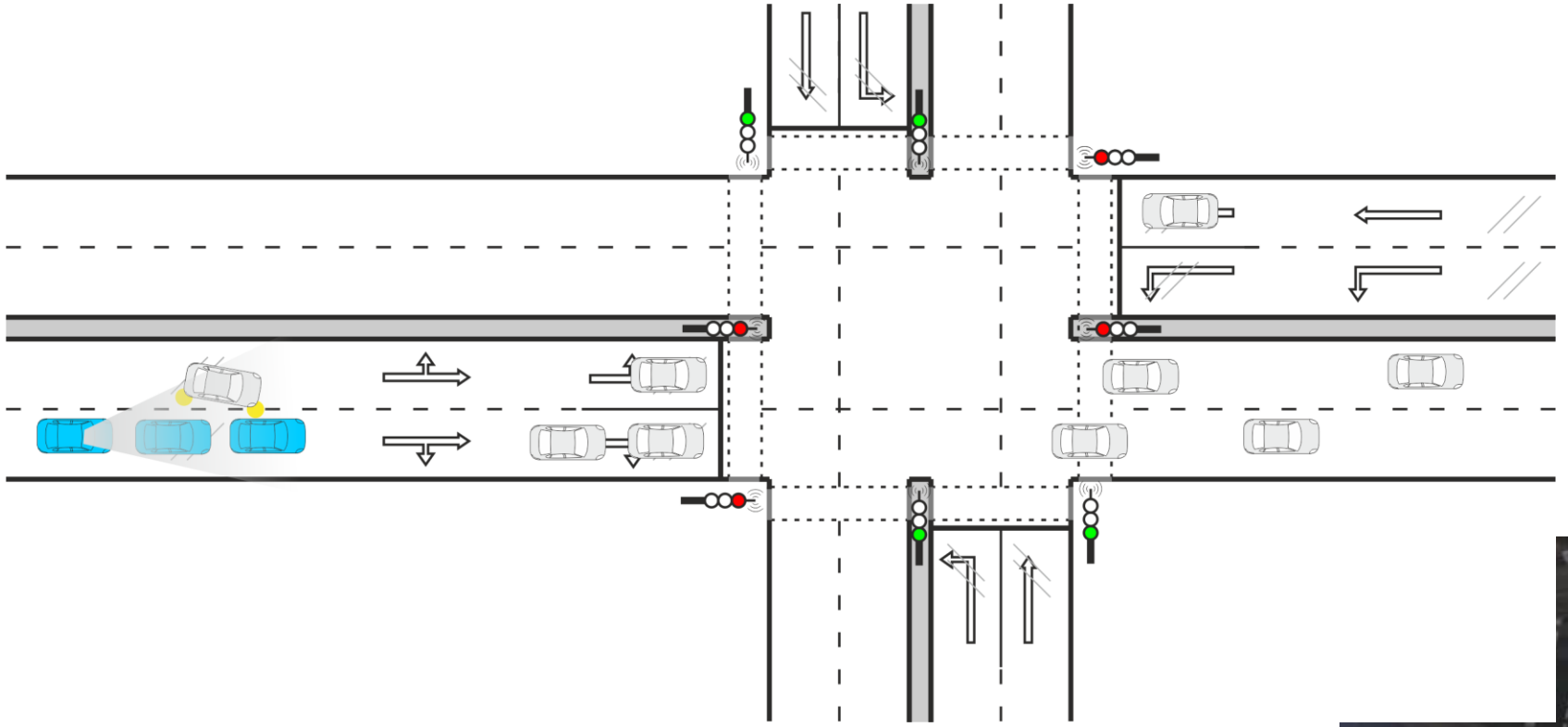
Objective #3:

ADAS techniques to prevent and/or mitigate dangerous situations.



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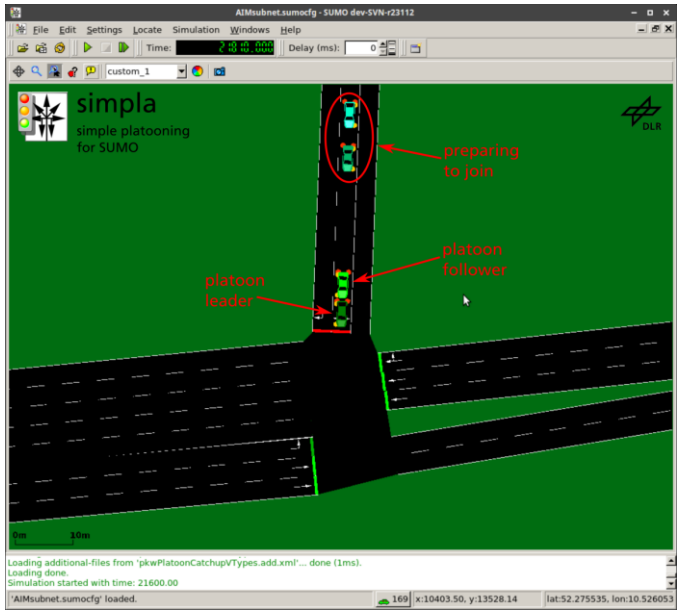
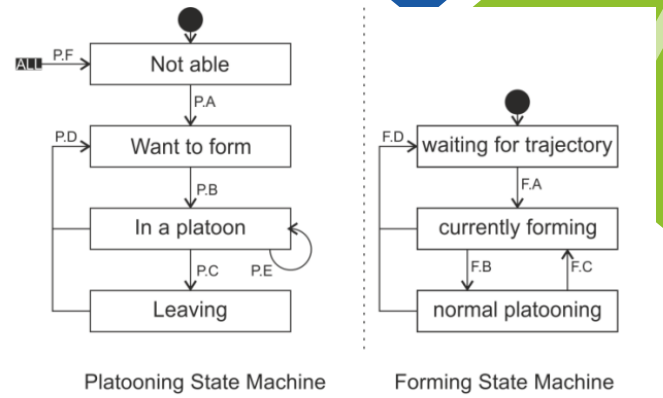
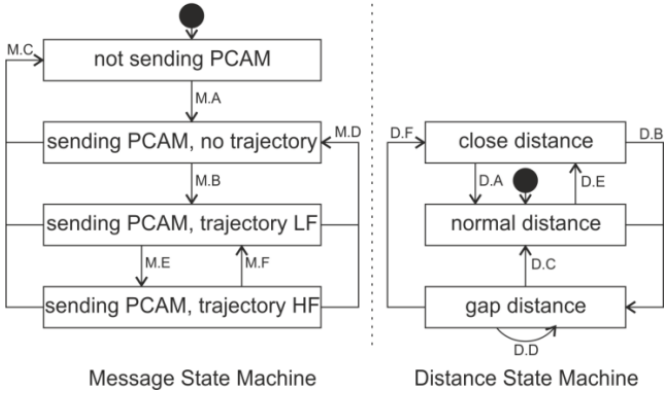
Objective #4:

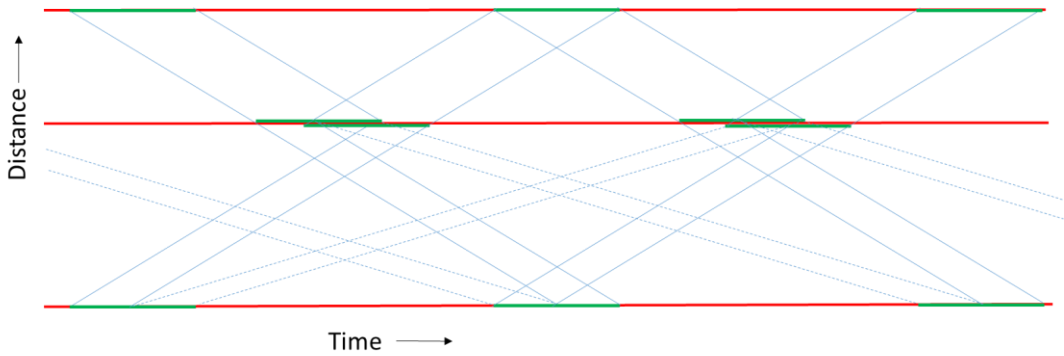
Develop, test, demonstrate and evaluate the MAVEN system.

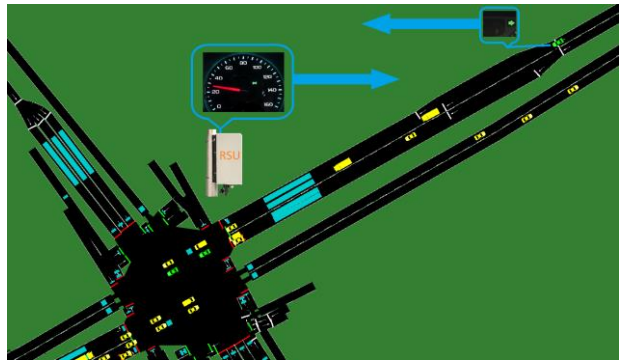


- Platoon Logic Development
- Simulation of
  - Platoons (forming, breaking…)
  - Lane-based queue length estimation
  - Agent-Aware GLOSA (AGLOSA)
  - Routing algorithms
  - Multi-Intersection Optimization









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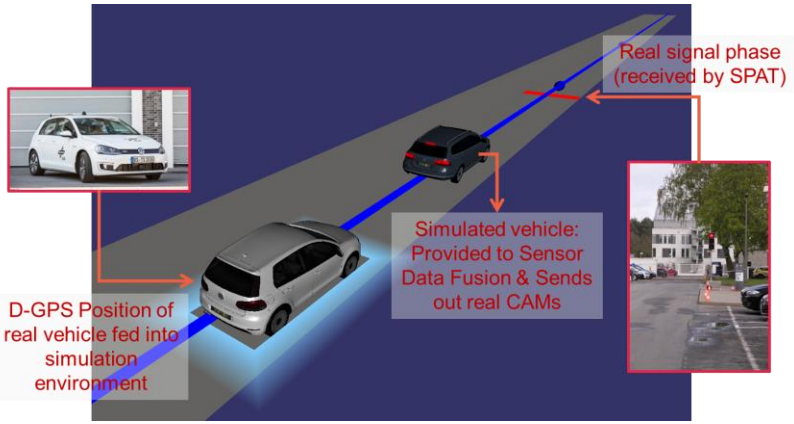
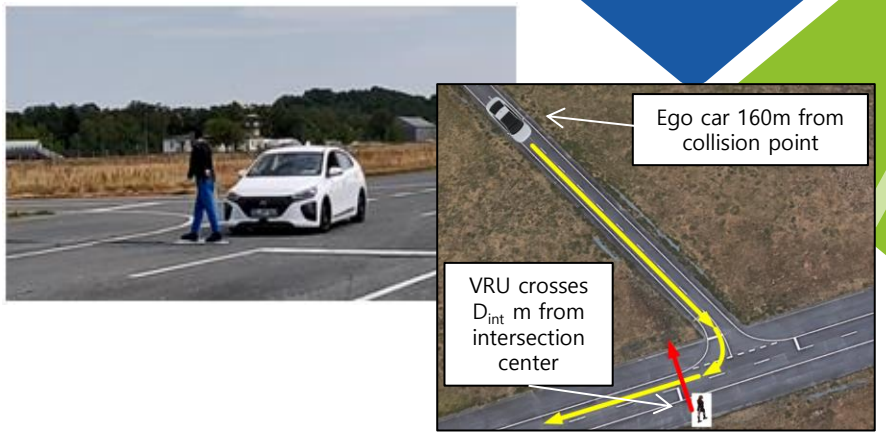
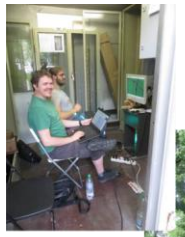
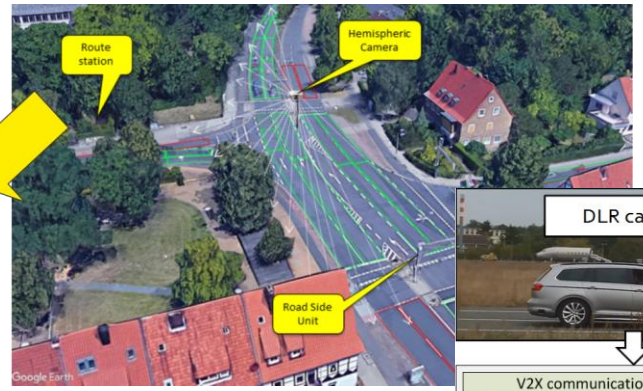
Objective #4:

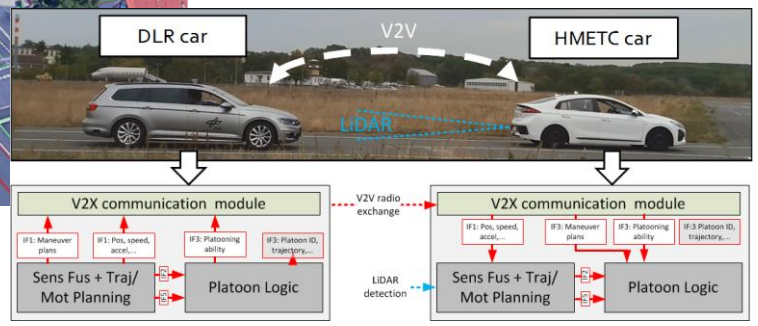
Develop, test, demonstrate and evaluate the MAVEN system.











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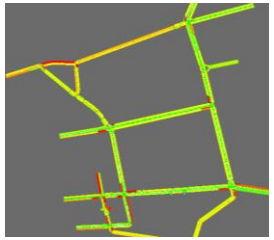
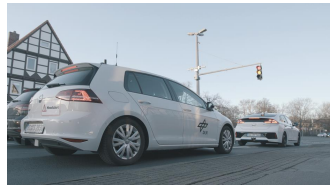
Objective #5:
Roadmap for the introduction of MAVEN-type systems

Survey with 209 respondents



SUMO Simulations of
Braunschweig,
Helmond and Praque



Real world trials with
questionnaires

Road authority & City interviews

Transition Roadmap
&
Whitepaper
“Management of
Automated Vehicles
in a Smart City Environment”

➔ http://maven-its.eu/

This project has received funding from the European Union’s Horizon 2020 research and innovation programme

Some brief results…

- **People have high expectations on the positive impact of automated vehicles (AVs)**
  - Over 80% of the respondents believe that CAVs will decrease the number of traffic accidents
  - About 70% of the respondents expect improvements in traffic congestions.
  - Most customers would pay a bit extra, up to 5000€ for a car with automated features.
- **Proper integration of AVs into a road infrastructure has clear positive effects on**
  - Emissions, Travel time, Traffic flow harmonization, Safety and many others
- **Already lower levels of penetration influence positively the travel experiences**
  - 20% penetration (Effect of Speed change advice and Green wave optimization)
    - - 17,3% delays
    - - 10,9% queue length
    - - 0,4% CO2
- **Different algorithms can aim at contradictory objective functions, so they must be combined carefully**
  - For example, minimizing delay does not necessarily lead to most harmonized traffic flow.
- **The transition phase however plays an important role**
  - The transition period (i.e. lower penetration rate of AVs) will strongly influence the impact
  - Other impacts of AVs depend on policies that are enabled by automation (car sharing, electro-mobility, and others)

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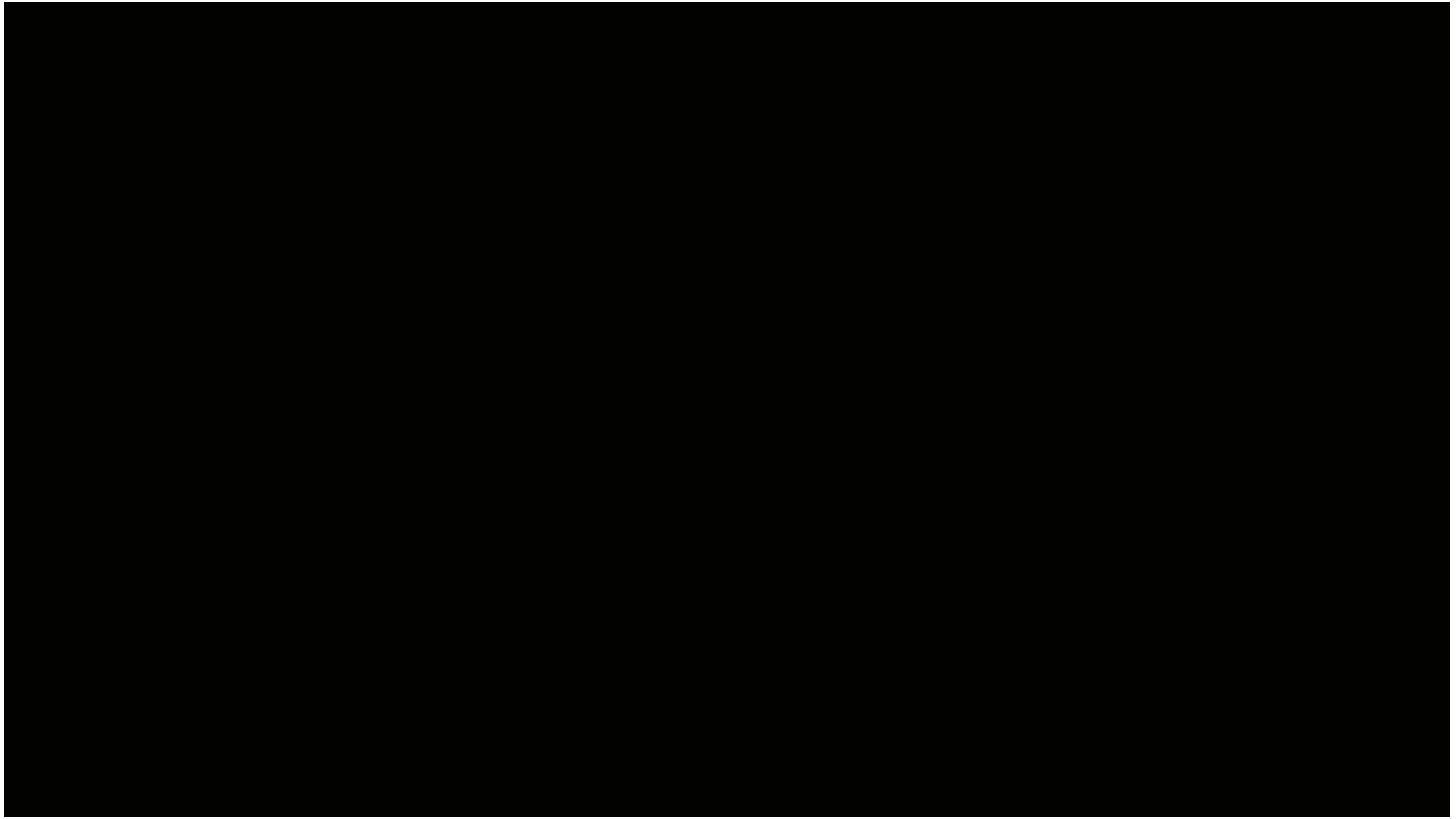
Thanks for listening!



Julian Schindler

German Aerospace Center (DLR)

julian.schindler@dlr.de

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