

TP1221: TS68 CAV TESTBEDS 1

@CITY - ATOMATED CARS AND INTELLIGENT TRAFFIC IN THE CITY

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Advanced Engineering

Aptiv Services Deutschland GmbH

Supported by:



Federal Ministry
for Economic Affairs
and Energy

on the basis of a decision
by the German Bundestag

OUTLINE



Project Setup

Partners

Structure

Current Developments

Timing and Milestones

CHALLENGES FOR AD IN URBAN ENV'T.



Complexity of the environment:

- ⊗ High information density and short reaction times
- ⊗ Multiplicity of dynamically changing scenarios
- ⊗ Occlusion of key objects for multiple observers
- ⊗ Complex lane geometries
- ⊗ Understanding of traffic topologies and flow patterns

Interactions with other road users:

- ⊗ Detection of road users' intentions and likely behavior
- ⊗ Prediction of the dynamic scenes with interactions
- ⊗ Interactions with vulnerable road users
- ⊗ Mix of automated and non-automated vehicles

Interactions between the driver and the vehicle:

- ⊗ Impact of higher degrees of automation on the driver's task
- ⊗ User-friendly transitions between different degrees of automation

MOTIVATION AND GOALS



Safety:

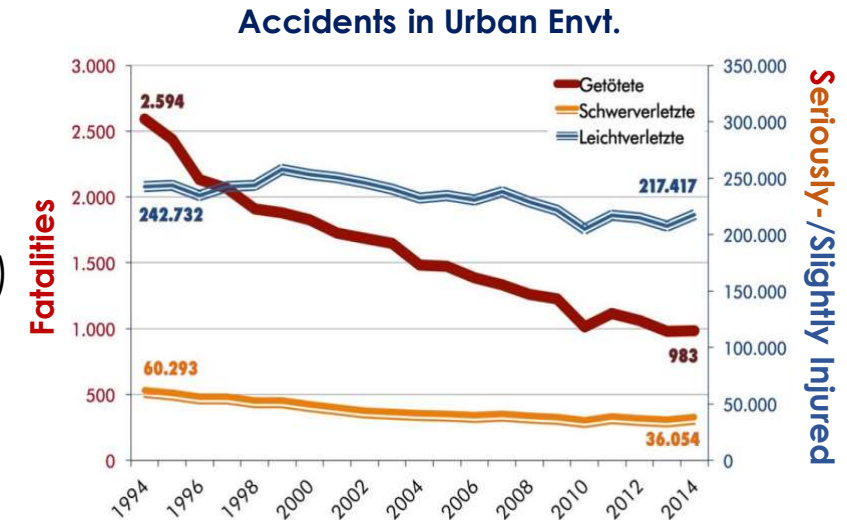
- ⊗ Reduction in the number of urban accidents
- ⊗ Seamless transition of automated driving functionality across road classes (not only on freeways and rural highways)
- ⊗ Stress-free driving in spite of high traffic complexity

Efficiency:

- ⊗ Better utilization of available infrastructure (roads, parking)
- ⊗ Provision of intelligent infrastructure (HD maps, traffic signals, ...)
- ⊗ Avoidance of apparent bottlenecks: road narrowing, opposing traffic, lane-merging, ...

Mobility:

- ⊗ Support for all age groups: from novice drivers to seniors
- ⊗ Demographic changes and urbanization



PROJECT SETUP



PHASE I

Scope:

- ⊗ Technologies, concepts and pilot applications for automated driving in city environment

Duration:

- ⊗ 4 years (01.09.2017 – 31.08.2021)

Total Budget:

- ⊗ 18.6 M€

Funding:

- ⊗ 7.8 M€

PHASE II

Scope:

- ⊗ Implementation of the concepts specified in @CITY
- ⊗ Cross-Functional Sub-Project: HMI

Duration:

- ⊗ 4 years (01.07.2018 – 30.06.2022)

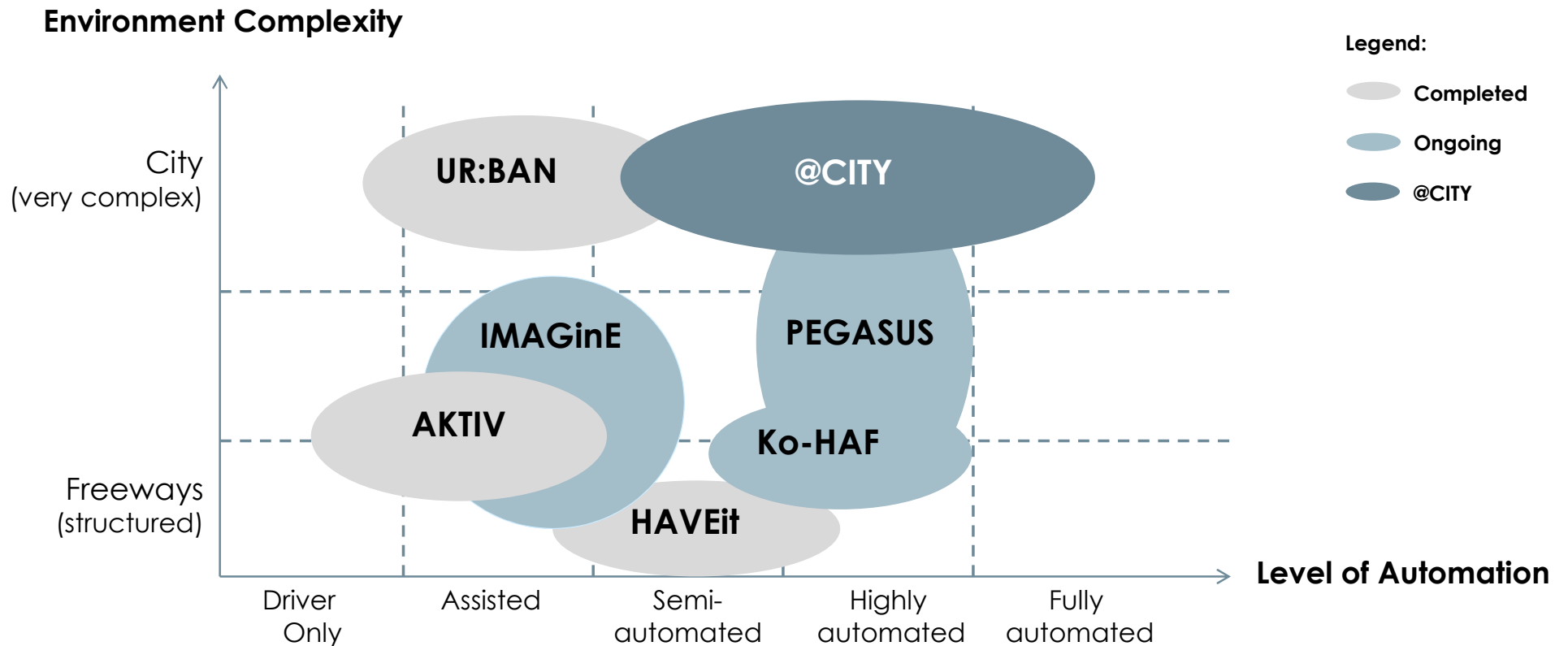
Total Budget:

- ⊗ 26.6 M€

Funding:

- ⊗ 12.5 M€

@CITY AND PROJECTS LANDSCAPE



PROJECT PARTNERS: @CITY



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PROJECT STRUCTURE

Environmental Perception and Situational Assessment (ES):

- 🚗 Environmental perception in urban areas
- 🚗 Situational assessment, prediction and interactions of road users



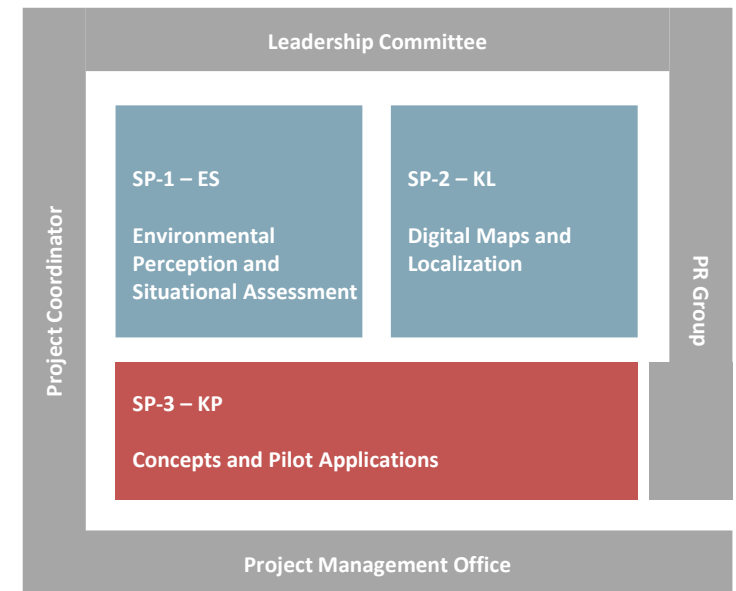
Digital Maps and Localization (KL):

- 🚗 High-resolution digital map as an additional sensor
- 🚗 Localization based on landmarks



Concepts and Pilot Applications (KP):

- 🚗 Definition, specification and simulation of use cases for the urban environment
- 🚗 Implementation of automated driving functions in pilot applications



SUB-PROJECT ES: ENVT. PERCEPTION & SITUATIONAL ASSESSMENT



Detection:

- ④ Detection of road users and obstacles
- ④ Landmark and infrastructure detection
- ④ Classification of areas as free, occupied, unknown/occluded

Situational Awareness:

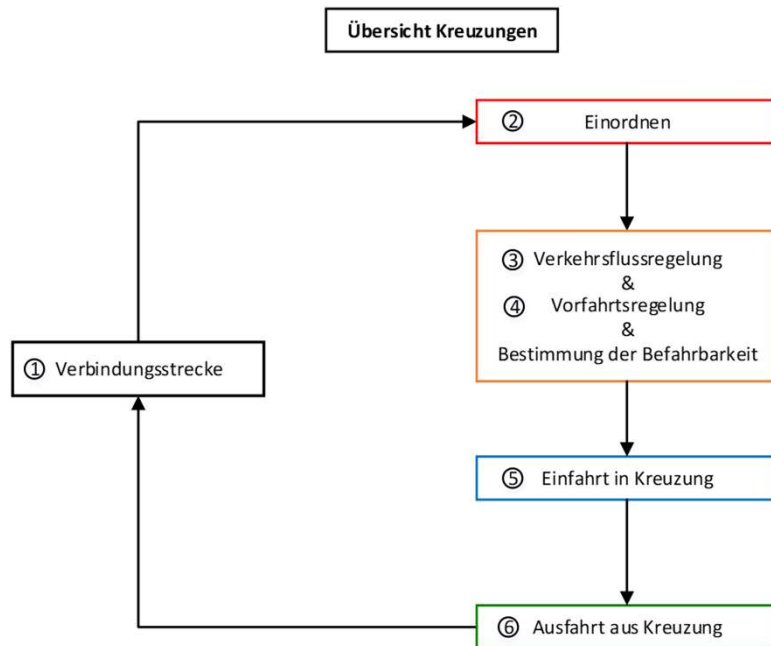
- ④ Awareness of traffic topologies and flow patterns
- ④ Verification by comparison with digital map data
- ④ Detection of road users' intentions and likely behavior

Prediction:

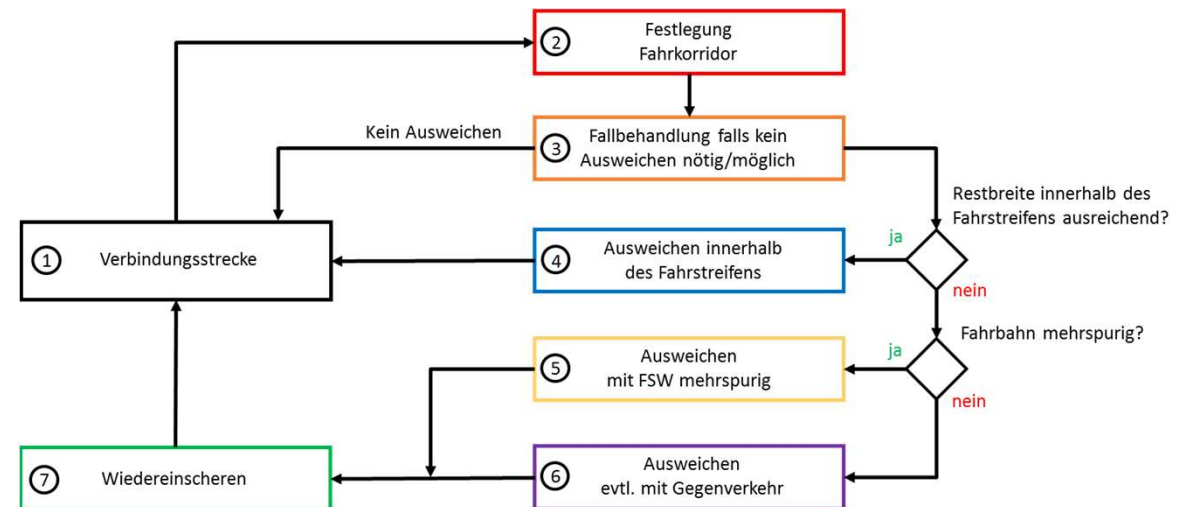
- ④ Interpretation of indicators for upcoming behavior
- ④ Use of prediction tools to improve environmental detection quality
- ④ Prediction of scene dynamics with interactions



SUB-PROJECT ES: ENVT. PERCEPTION & SITUATIONAL ASSESSMENT

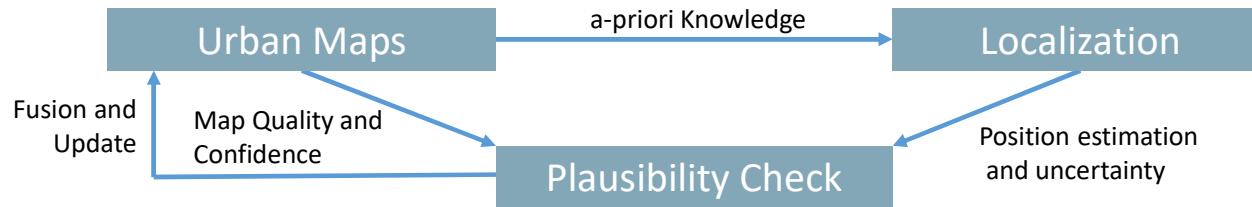


Embedding of the "Intersection" scenario in the overall context, as well as the rough subdivision of the scenario into six different sub-sections



Overview of the procedure of the scenario "Driving on a connecting route with a bottleneck"

SUB-PROJECT KL: DIGITAL MAPS AND LOCALIZATION



Urban Maps:

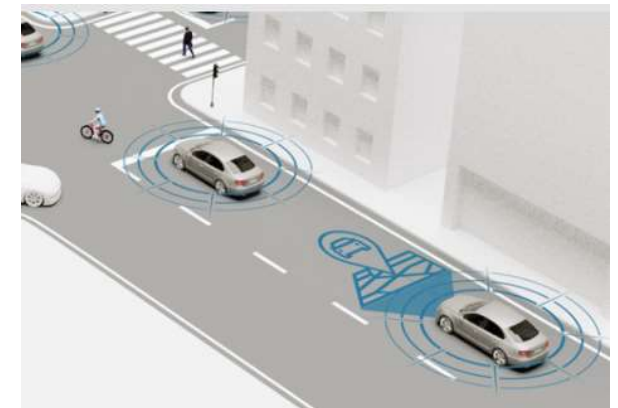
- ⊗ Derivation of requirements for digital maps based on specified use cases
- ⊗ Definition of map format and creation of a high-resolution base map

Localization:

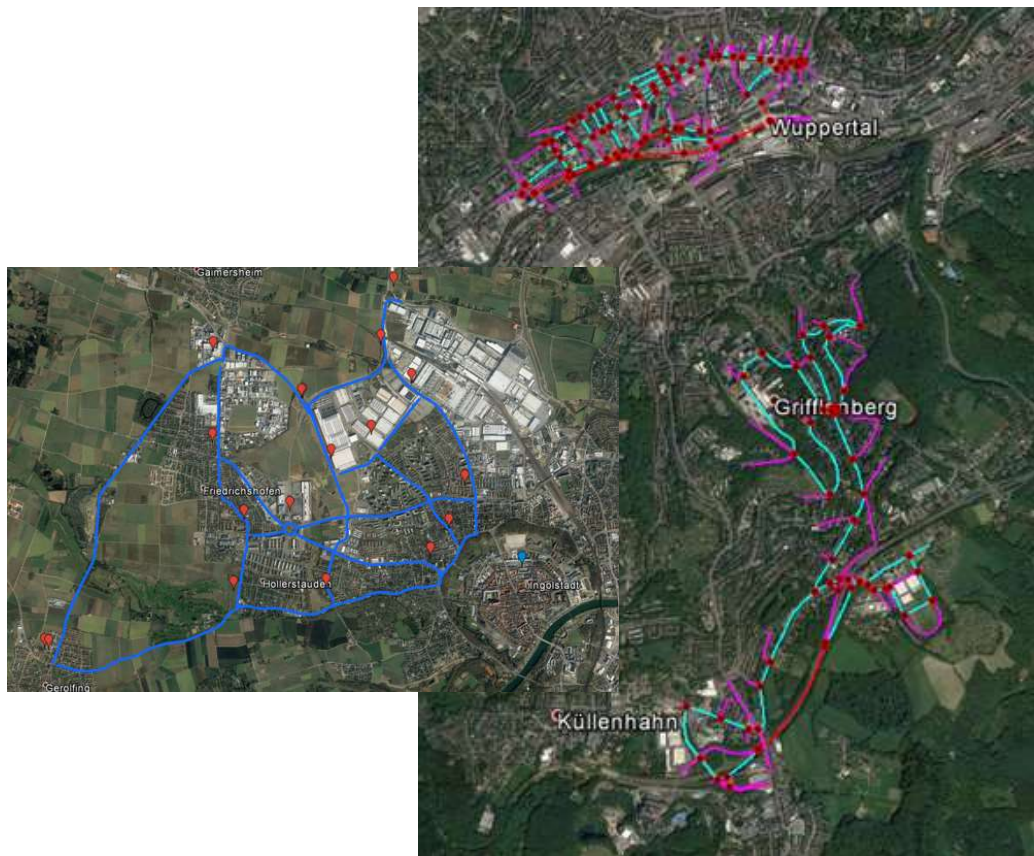
- ⊗ Sensor based self-localization and map matching relative to map content/attributes
- ⊗ Detection and definition of landmarks, estimation of localization accuracy

Plausibility Check:

- ⊗ Development of a metric to characterize data plausibility between maps and sensors



SUB-PROJECT KL: DIGITAL MAPS AND LOCALIZATION



Signale (signals)	
Schilder nach vzkat 2017	
Dynamische Schilder	
Ampeln	
Spurgültigkeit falls erforderlich	
Zebrastrifen, Pfeile, Grenzmarkierung Parkverbot (Mittelpunkt)	
Haltelinien, Wartelinien	
Richtungswinkel für Schilder	
Sonstige Schilder (Straßennamen, Privat, Kilometerungstafeln...)	
Fußgängerampeln	
Textangaben auf Schildern	
Objekte (objects)	
Leitpfosten	
Straßenlaternen	
Frostsen (Gehwegpfosten, Schilderpfosten)	
Masten (Telefonmasten, Fahnenstangen...)	
Ampelpfosten	
Baum	
Straßenmarkierungen - Pfeile	
Straßenmarkierung - Text, Nummer, Symbol	
Notrufsäule	
Leitplanke	
Betonsteiner	
Brücke	
Tunnel	
Schilderbrücke	
Parkplätze	
-> Parkplätze. Genaue Angabe der Markierungen -> spec 1.5	
Mittelinseln	
-> Mittelinseln. Detaillierte Beschreibung der Einzelnen Flächen und Höhen -> spec 1.5	
Busch	
Zaun	
Geländer	
Hydrant	
Parkbank	
Verteilerkasten	
Gebäude, Baukörper - LOD1	
-> Gebäude: LOD1 mit Differenzierung unterschiedlicher Baukörperhöhen eines Gebäude	
Mauer	
Lärmschutzwand	
Tunnelwand	
Umriss Schildfläche	
Straßenmarkierungen - Haltelinien Umriss	
Straßenmarkierungen - Wartelinien Umriss	
Straßenmarkierung - Sonstige	
Zebrastrifen Gesamtumriss	
Fußgängerfurten, Fahrradfurten	
Überwege ohne Markierung	
Sonstige Hindernisse	
Fundament	
Ampelkästen	
Gullideckel (hinzugefügt @ City)	



SUB-PROJECT KP: CONCEPTS AND PILOT APPLICATIONS



Specifications and Concepts:

- ⊗ System specification to facilitate AD in urban areas
- ⊗ Definition of scenarios to ensure AD across urban nodes as well as interaction with VRUs
- ⊗ Requirements specifications (feedback)



Pilot Applications ,Dynamic Bottlenecks':

- ⊗ Modelling of a scenario for planning
- ⊗ Implementation of a suitable driving strategy
- ⊗ Building up prototype test vehicles and testing the same with implemented ADFs



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PROJECT PARTNERS: @CITY-AF



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PROJECT STRUCTURE: @CITY-AF



Human-Machine-Interaction (MF):

- ⊗ User interaction in complex traffic situations
- ⊗ Communication with other road users



Urban Nodes (UK):

- ⊗ Urban nodes taking into account traffic rules and other road users
- ⊗ Predictive and cooperative behavior at intersections and roundabouts



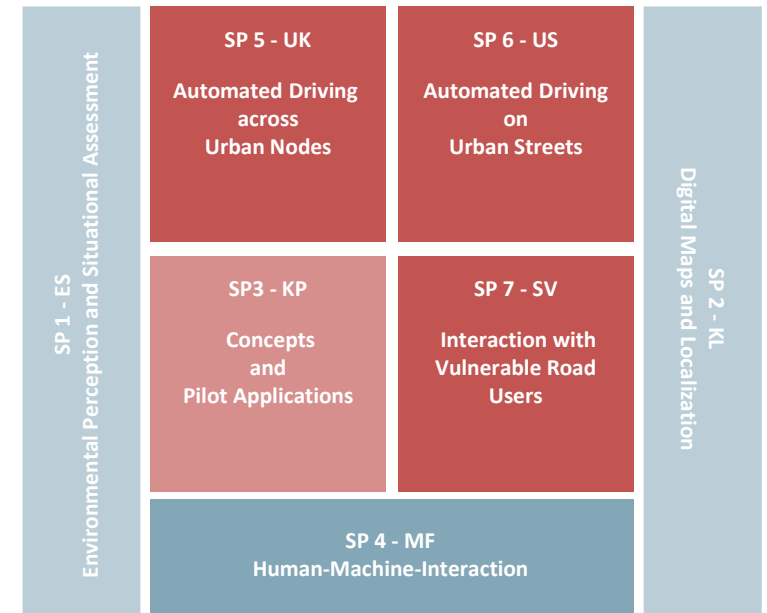
Urban Streets (US):

- ⊗ Urban journey planning on connecting routes
- ⊗ Methods for the traffic- and user-oriented realization of the driving strategy



Interaction with VRU (SV):

- ⊗ Detection and Classification of VRUs
- ⊗ Recognition and interpretation of relevant poses and gestures
- ⊗ Intention Prediction of VRUs / VRU-Groups



SUB-PROJECT MF: HUMAN-MACHINE-INTERACTION



User Interaction in Complex Traffic Situations:

- ⊗ Definition of driver-related interaction requirements and their evaluation with regard to their relevance for safety and acceptance
- ⊗ Identification and development of relevant HMI components

Communication with Other Road Users:

- ⊗ Scenario analysis of natural communication channels
- ⊗ Identification of relevant communication channels
- ⊗ Development of communication and interaction concepts

Assessment:

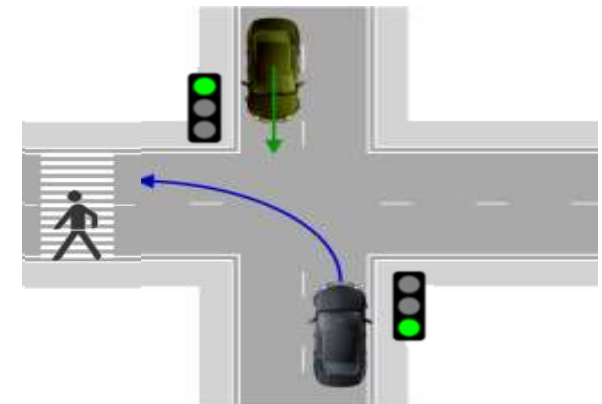
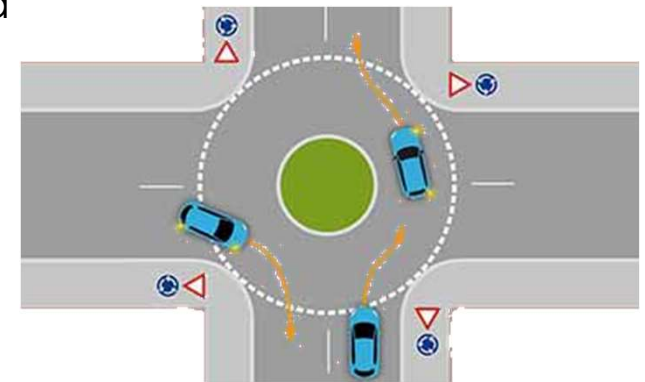
- ⊗ User studies, acceptance of automation concepts
- ⊗ Test methods & criteria for the evaluation of HMI concepts
- ⊗ Consistent evaluation methodology incl. standardization
- ⊗ Design recommendations for HMI solutions in automated vehicles



SUB-PROJECT UK: AUTOMATED DRIVING ACROSS URBAN NODES



- ④ Control of junctions as elementary situation building blocks in road traffic
- ④ Predictive and cooperative behavior
- ④ Development of driving strategies
- ④ Environment and trajectory planning, traffic assessment and prediction
- ④ Development of common methods for testing functional optimization: Use of simulation and tests to optimize the new ADFs
- ④ System evaluation



SUB-PROJECT US: AUTOMATED DRIVING ON URBAN STREETS



- ④ Urban journey planning on connecting routes
- ④ Methods for traffic- and user-oriented realization of the driving strategy
- ④ Implementation in prototype test vehicles
- ④ Joint system assessment
- ④ Focus on characteristic scenarios:
 - ④ Settlement traffic (e.g. traffic-calmed zones)
 - ④ Bottlenecks (construction sites, delivery traffic, second row parkers)
 - ④ Bus - public transport (bus stop situation, bus stop bay with threading and unthreading)

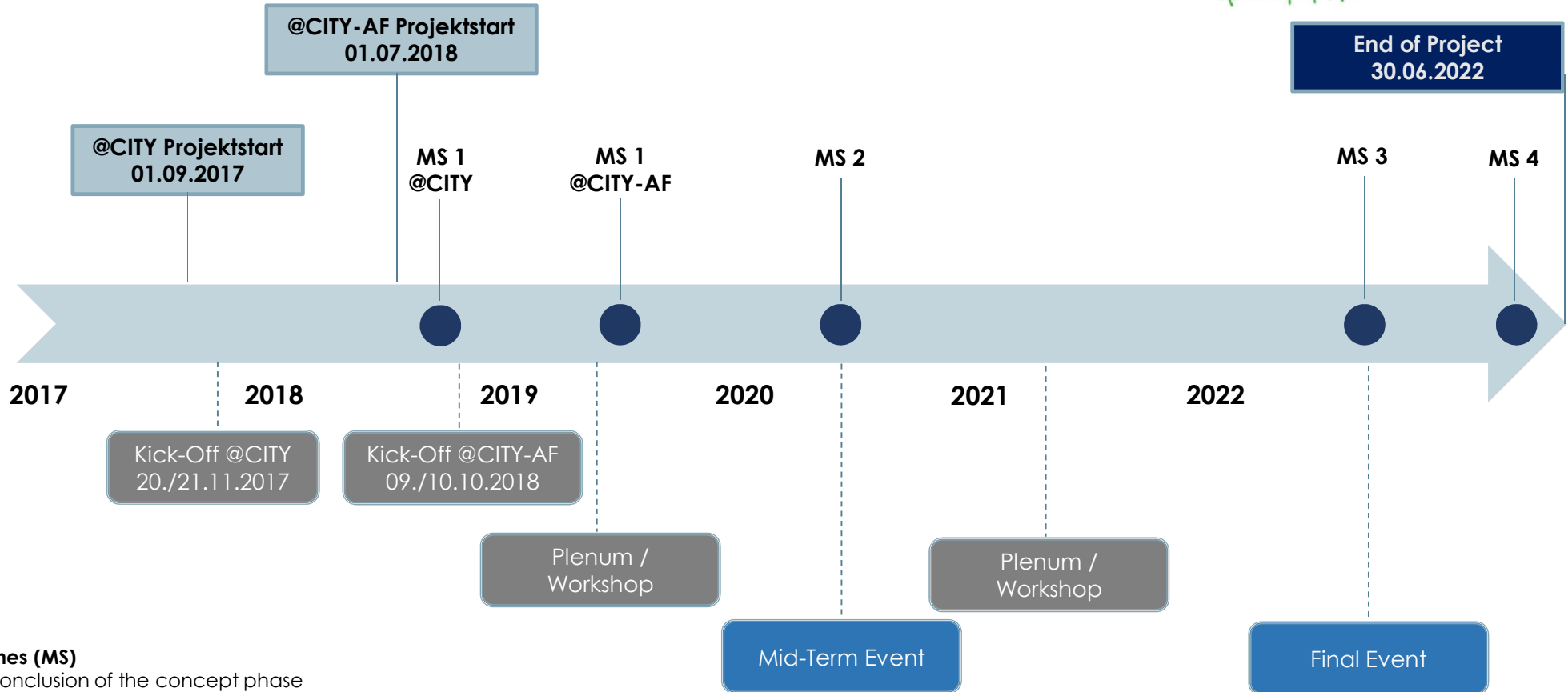


SUB-PROJECT SV: INTERACTION WITH VRU

- ⊗ VRUs in road traffic communicate consciously or unconsciously by means of poses and gestures, e.g. turning of a pedestrian's gaze, hand signal of a cyclist turning, etc.
- ⊗ Traffic situations require cooperation with VRU, e.g. at pedestrian crossings
- ⊗ Detection and Classification of VRUs
 - ⊗ Partial covering, pedestrian groups (group dynamics)
 - ⊗ special VRUs like traffic policemen, construction workers,...
- ⊗ Recognition and interpretation of relevant poses and gestures
- ⊗ Intention prediction of VRUs / VRU groups taking into account the scene context



TIMING AND MILESTONES



Milestones (MS)

- MS 1: Conclusion of the concept phase
- MS 2: Sensors, actuators and ECUs integrated into test vehicles
- MS 3: Automated driving functions available in the city
- MS 4: Evaluation phase completed

SUB-PROJECTS



SP 1
Environmental
Perception and
Situational Assessment



SP 2
Digital Maps
and
Localization



SP 3
Concepts
and
Pilot Applications



SP 4
Man- Machine
Interaction



SP 5
Automated Driving
across
Urban Nodes



SP 6
Automated Driving
on
Urban Streets



SP 7
Interaction with
Vulnerable
Road Users

Neu Technologies, Concepts and Pilot Applications

Automated Driving Functions



Automatisiertes Fahren in der Stadt

THANK YOU