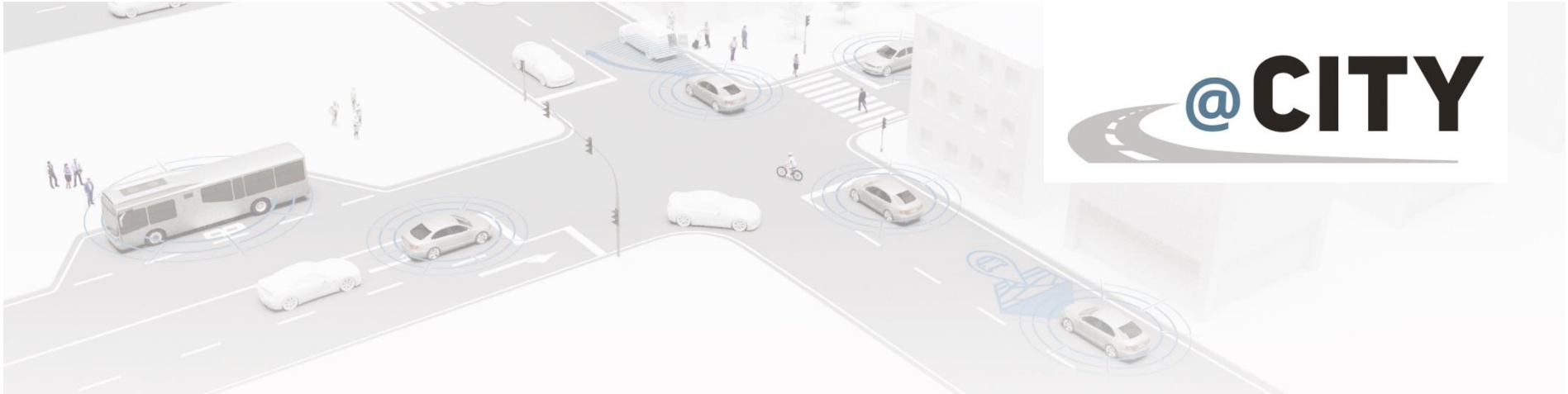
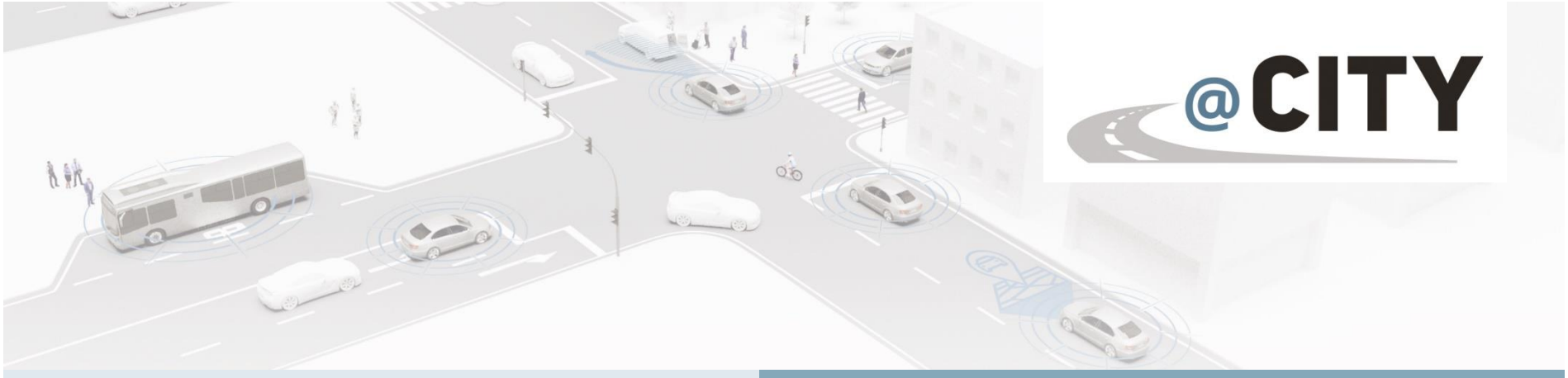


@CITY - Automated Cars and Intelligent Traffic in the City

Automotive meets Electronics (AmE) 2019

Supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag



Outline

- Project Structure
- Partners
- Research Focus and Current Development Status
- Timing and Milestones
- Summary

Project Structure

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)

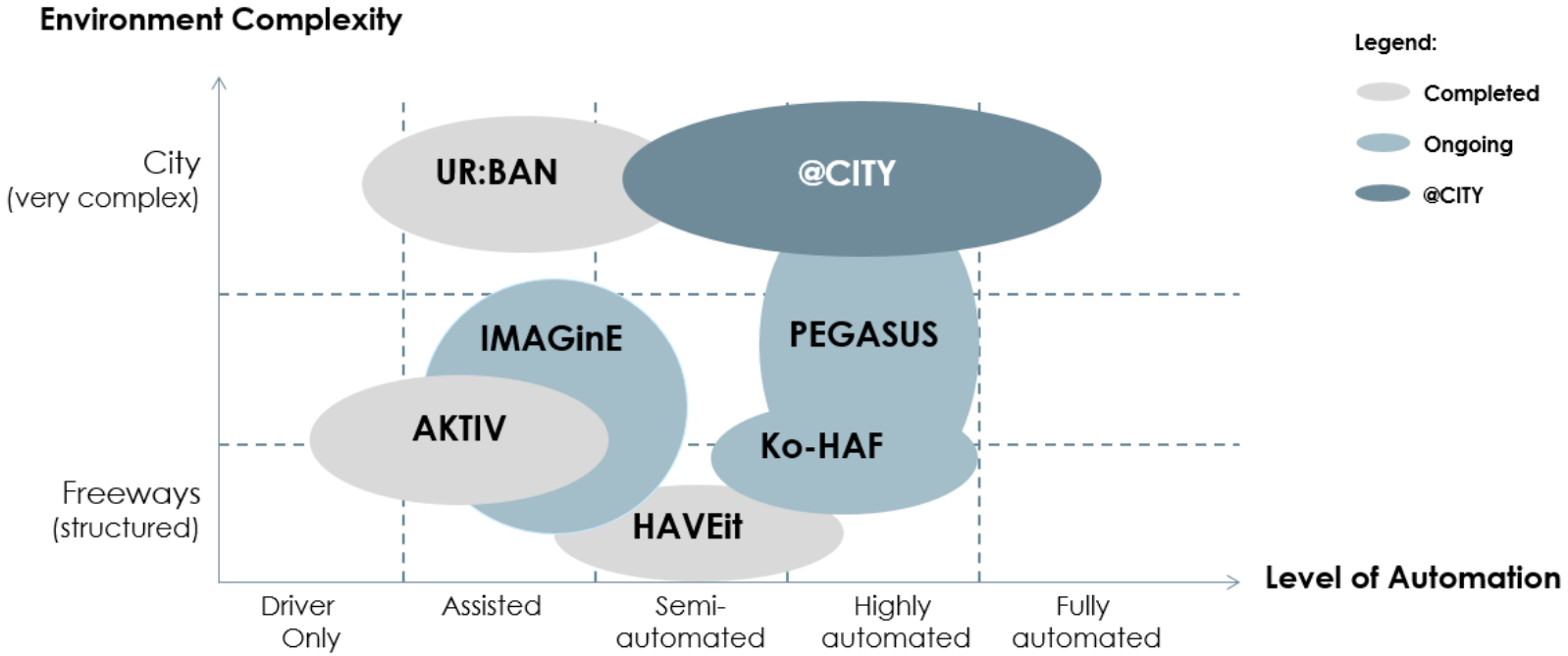
Total Budget:

- 26.6 M€

Funding:

- 12.5 M€

Mapping @CITY to Projects Landscape



Partners: @CITY

SMEs

3D MAPPING SOLUTIONS

OEMs

DAIMLER

Suppliers

APTIV

BOSCH
Technik fürs Leben

Continental

Valeo
SMART TECHNOLOGY FOR SMARTER CARS

ZF

Research

@CITY

Partners: @CITY-AF

SMEs

3D MAPPING SOLUTIONS

OEMs

DAIMLER

MAN

Suppliers

APTIV

BOSCH
Technik fürs Leben

Continental

Valeo
SMART TECHNOLOGY FOR SMARTER CARS

ZF

Research

TECHNISCHE UNIVERSITÄT DARMSTADT

DLR

TECHNISCHE UNIVERSITÄT CHEMNITZ

@CITY Project Structure

Environmental Perception and Situational Assessment (ES):

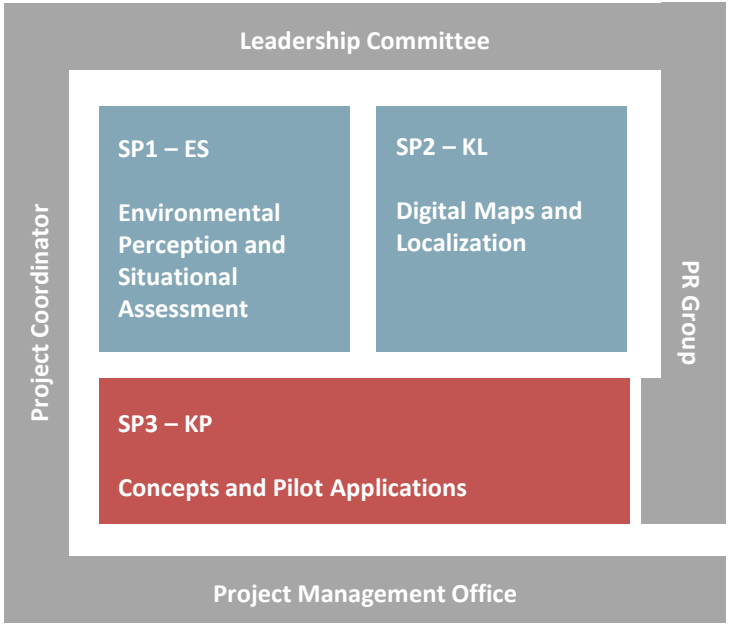
- Environmental perception in urban areas
- Situational assessment, prediction and interactions of road users

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
- Implementation of automated driving functions in pilot applications



@CITY-AF Project Structure

Human-Machine-Interaction (MF):

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

Urban Nodes (UK):

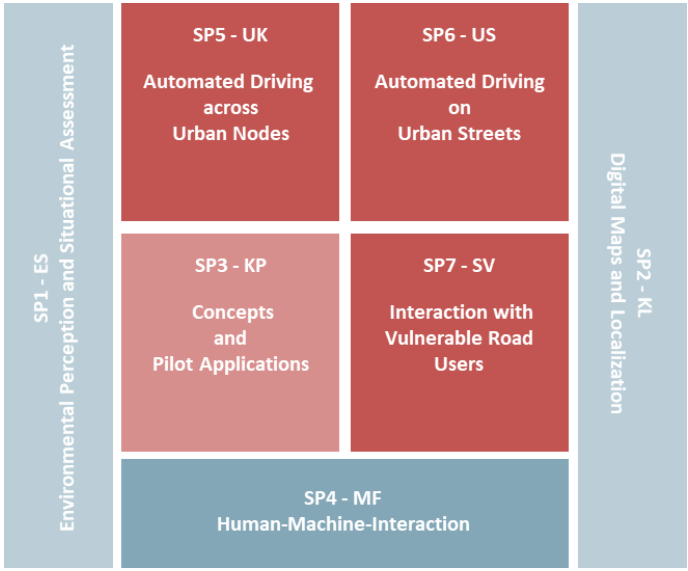
- Urban nodes taking into account traffic rules and other road users
- Predictive and cooperative behavior at intersections and roundabouts

Urban Streets (US):

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

Interaction with VRUs (SV):

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



Research Focus & Current Status

SP1: Environmental Perception and Situational Assessment

Detection:

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

Situational Awareness:

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

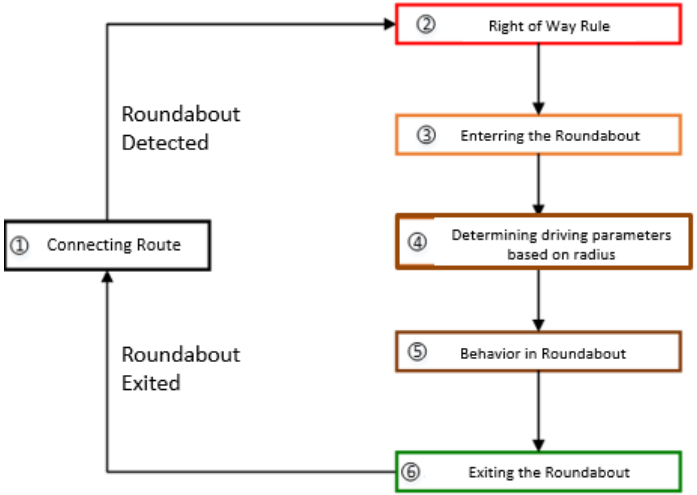
Prediction:

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

SP1: Environmental Perception and Situational Assessment

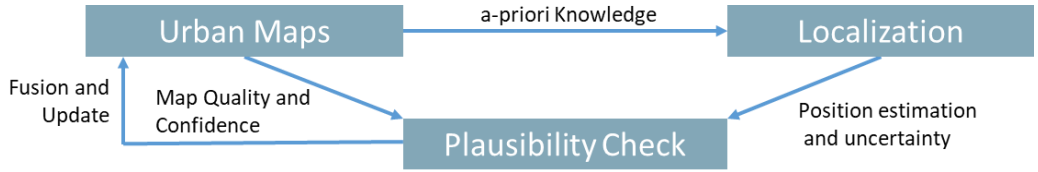
Requirements Specification:

- Deriving requirements from the scenarios of urban nodes such as intersection and roundabouts.
- Harmonizing requirements despite different project partner-specific system characteristics (and thus different sensor sets).



Process flow description of urban node "roundabout"

SP2: 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

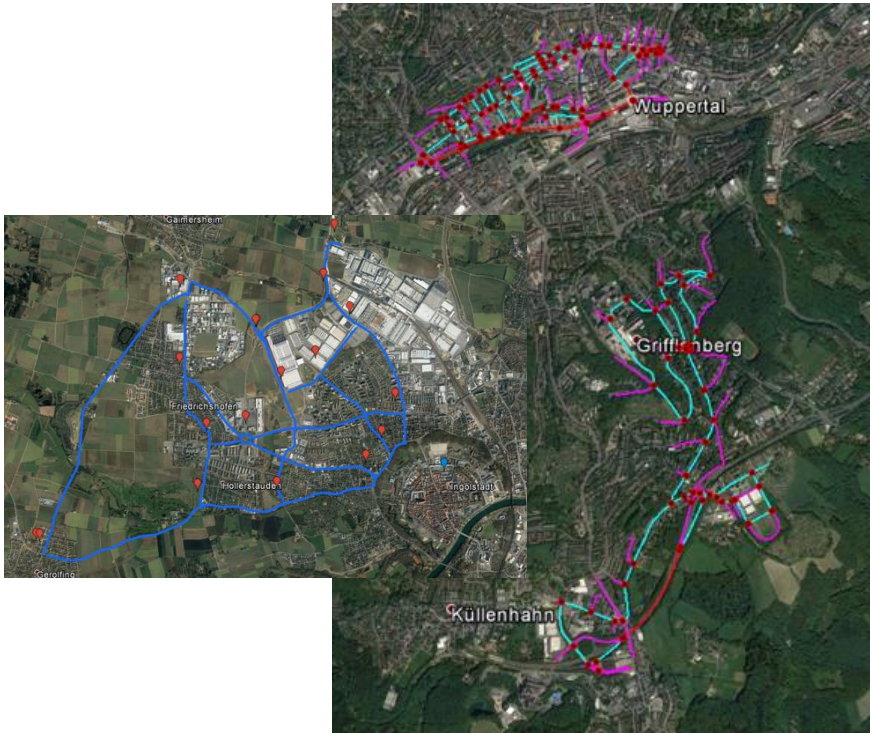
Plausibility Check:

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

Source: 3D Mapping Solutions GmbH

SP2: Digital Maps and Localization

Specification of Urban Road Segment



Object Catalogue

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Signale <signals>	
Schilder nach vzkat 2017	http://www.bast.de/DE/Verkehrstechnik/Fachthemen/v1-verkehrszeichen/vz-start.html
Dynamische Schilder	
Ampeln	Typen nach OpenDRIVE Spec 1.4
Spurgültigkeit falls erforderlich	
Zebrastreifen, Pfeile, Grenzmarkierung Parkverbot (Mittelpunkt)	
Haltelinien, Wartelinien	
Richtungswinkel für Schilder	
Sonstige Schilder (Straßennamen, Privat, Kilometrierungstafeln...)	
Fußgängerampeln	Typen nach OpenDRIVE Spec 1.4
Textangaben auf Schildern	

Objekte <objects>	
Leitpfosten	
Straßenlaterne	
Pfosten (Gehwegpfosten, Schilderpfosten)	
Masten (Telefonmasten, Fahnenstangen...)	
Ampelpfosten	
Baum	
Straßenmarkierungen - Pfeile	
Straßenmarkierung - Text, Nummer, Symbol	
Notrufsäule	
Leitplanke	
Betonteiler	
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	
Zebrastreifen Gesamtumriss	
Fußgängerfurten, Fahrradfurten	
Überwege ohne Markierung	
Sonstige Hindernisse	
Fundament	
Ampelkästen	
Gullideckel (hinzugefügt @City)	

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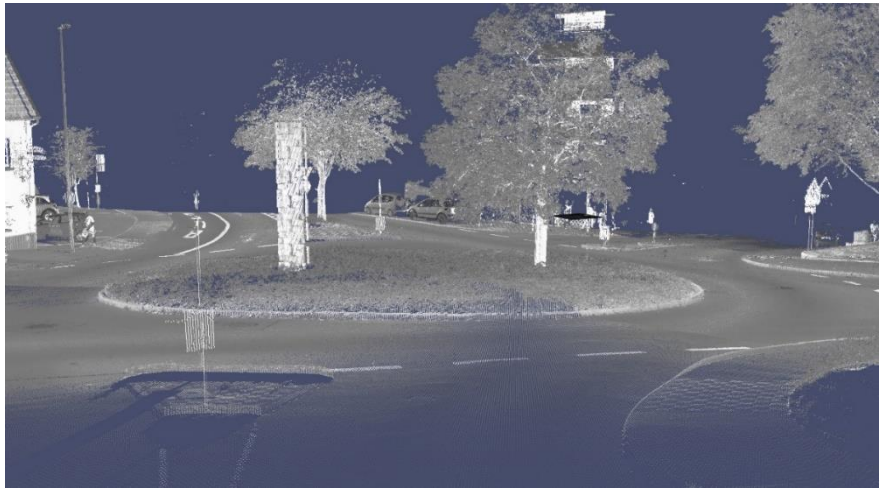
Example: Wuppertal Road Segment



Scanner Data

Camera Data

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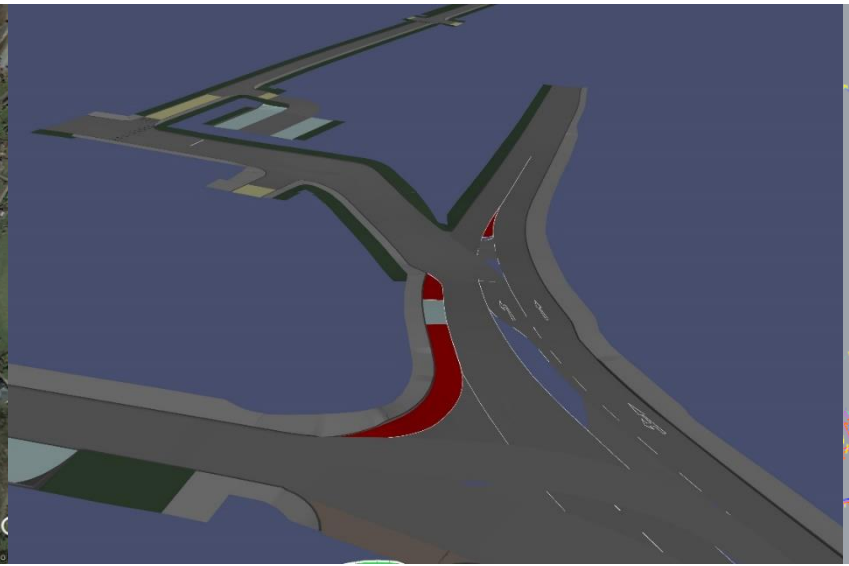
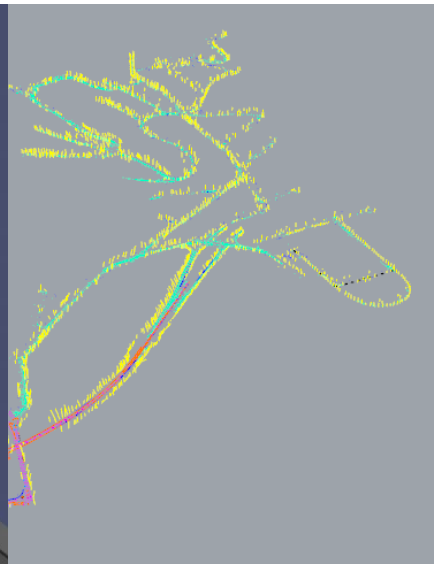
Example: Wuppertal Road Segment

Road Segment



Track Model



Static Objects + Signals

SP3: Concepts and Pilot Applications

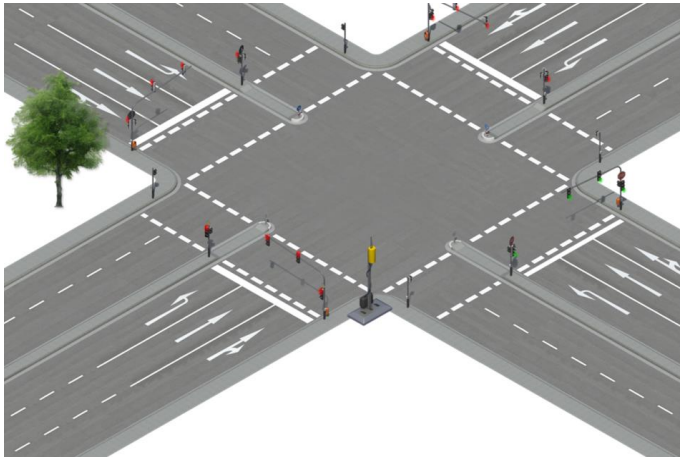
Specifications and Concepts:

- 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)

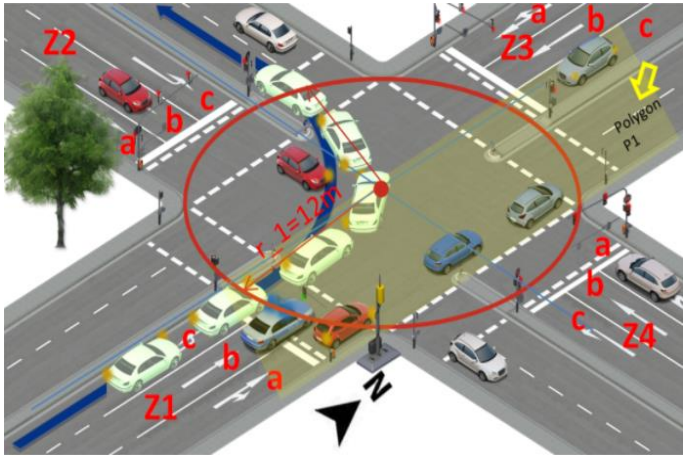
Pilot Applications ‚Dynamic Bottlenecks‘:

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

SP3: Concepts and Pilot Applications



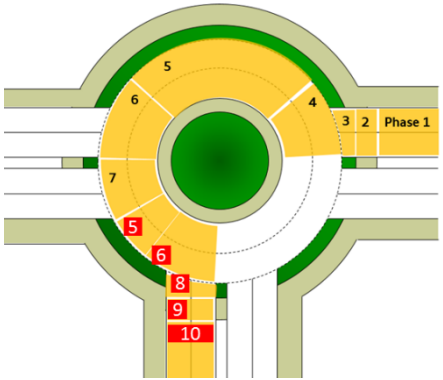
Multi-lane intersection with numerous static elements



Multi-lane intersection expanded with numerous dynamic elements

SP3: Concepts and Pilot Applications

- System specification for automated vehicle guidance in urban areas.
- Phase-wise model approach for scenario description.
- Creation of a situation catalogue with relevant driving scenarios.
- Definition of test scenarios and test metrics for the other subprojects in order to ensure a common, cross-partner understanding of the system.
- To describe scenarios in the form of "logical scenarios", the description languages Open Drive (for stationary scopes) and Open Scenario (for moving scopes) are used in PEGASUS.



Phase	Beginn	Ende
1	Zufahrt auf den Kreisverkehr vor der Querungshilfe	Anfang der Querungshilfe
2	Anfang der Querungshilfe	Ende der Querungshilfe
3	Ende der Querungshilfe	Einfahrt zum Kreisverkehr
4	Einfahrt zum Kreisverkehr	Zielspur des Kreisverkehr inkl. Manöverraum
5	Zielspur des Kreisverkehr inkl. Manöverraum	Zufahrt auf Ausfahrtmöglichkeit
6	Zufahrt auf Ausfahrtmöglichkeit	Zufahrt auf Einfahrtmöglichkeit
7	Zufahrt auf Einfahrtmöglichkeit	Ende der Einfahrtmöglichkeit
5	Ende der Einfahrtmöglichkeit	Zufahrt auf Ausfahrtmöglichkeit
6	Zufahrt auf Ausfahrtmöglichkeit	Ende der Ausfahrtmöglichkeit
8	Ende der Ausfahrtmöglichkeit	Anfang der Querungshilfe
9	Anfang der Querungshilfe	Ende der Querungshilfe
10	Ende der Querungshilfe	Abfahrt vom Kreisverkehr

Representation of a driving maneuver at a roundabout with the phase model

SP4: 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

SP5: Automated Driving across Urban Nodes

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

SP6: Automated Driving on Urban Streets

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

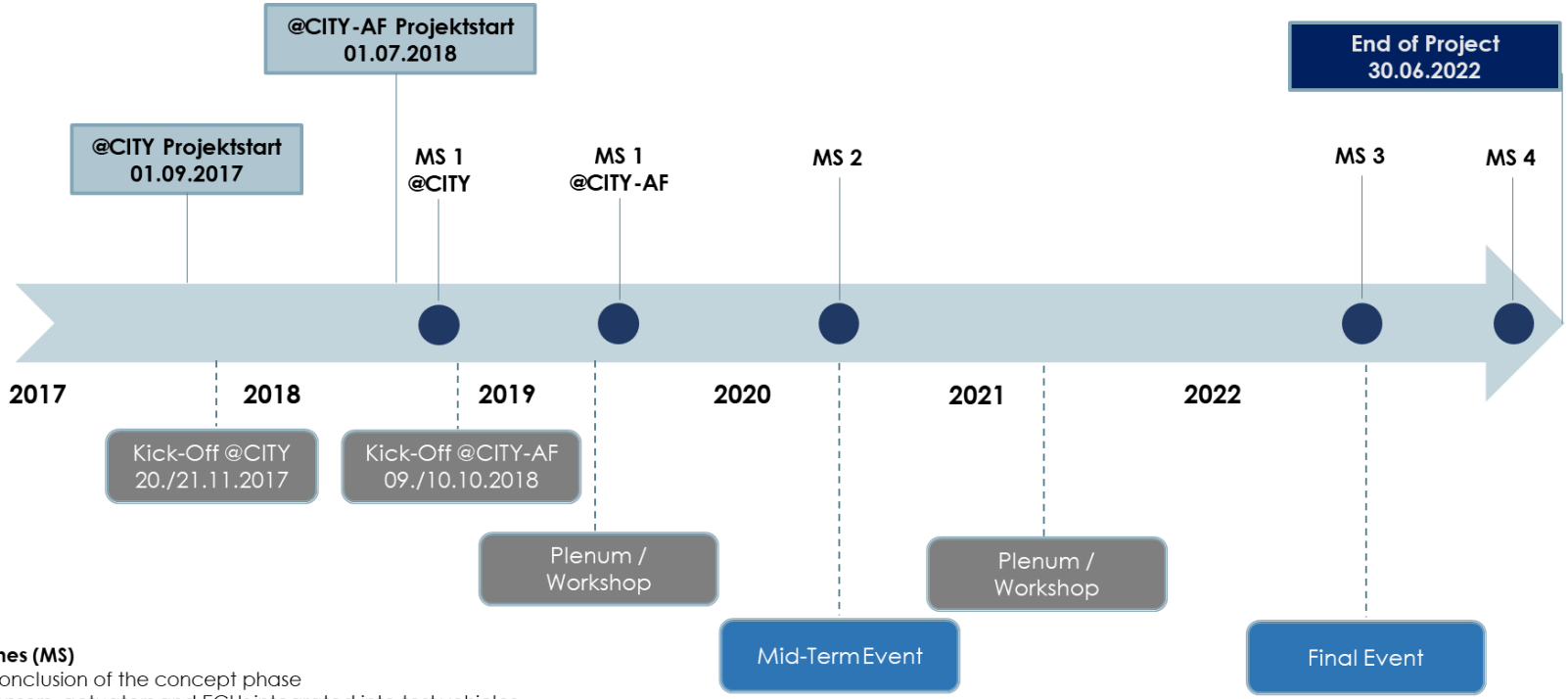
Source:
MAN Truck & Bus AG

SP7: Interaction with Vulnerable Road Users (VRUs)

- 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

Project Timing and Milestones Plan



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

Summary

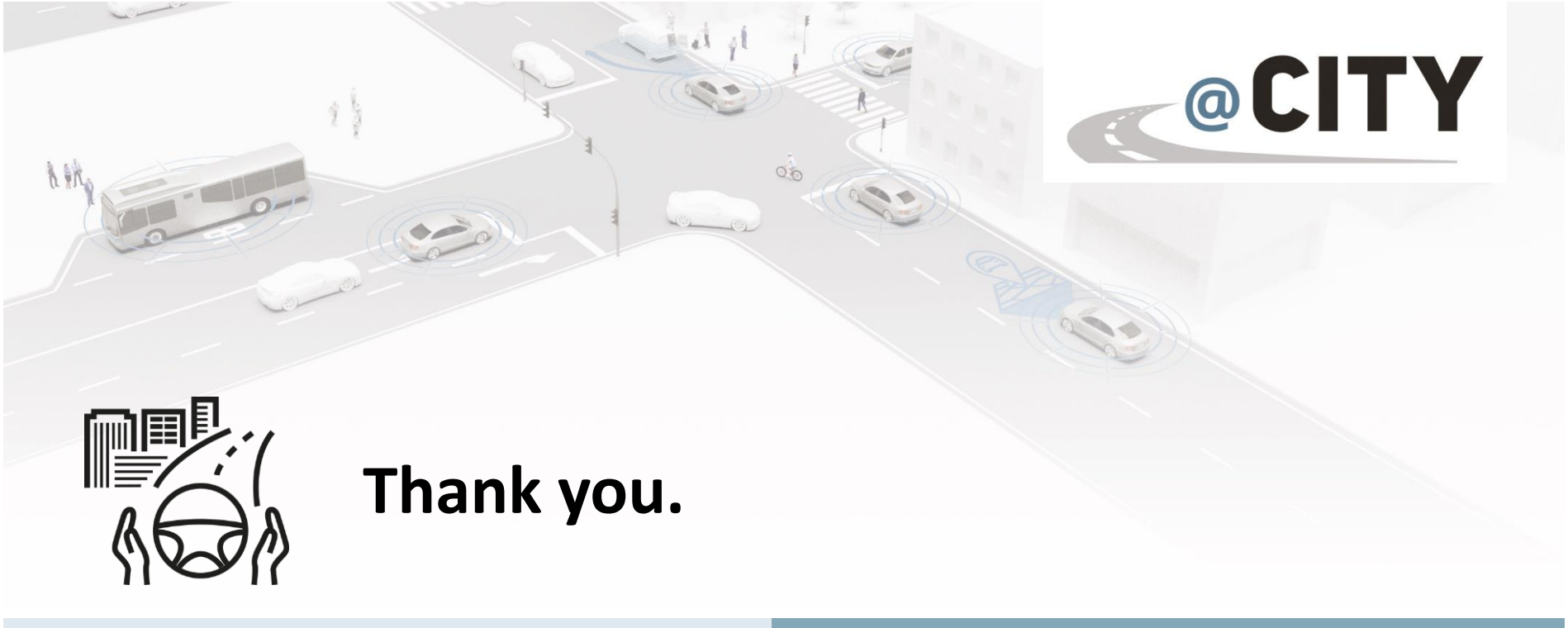
Summary

@CITY

SP 1 | SP 2 | SP 3 | SP 4 | SP 5 | SP 6 | SP 7

Phase I — **New Technologies, Concepts and Pilot Applications**

Phase II — **Automated Driving Functions**



Thank you.

www.atcity-online.de

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