Automated Driving in Complex Inner-City Scenarios

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Symposium “Urban Mobility Challenges”, 12th November 2018



NIEDERSÄCHSISCHES FORSCHUNGSZENTRUM FAHRZEUGTECHNIK

Technische Universität Braunschweig

Agenda

Projects Urban AD

Example for a Complex Scenario: Left Turn

Research Vehicles & Driving Functions



Projects - Urban Automated Driving



Digitaler Knoten 4.0

2016 –2019

With support from



by decision of the German Bundestag



Cooperation & Interaction between AD-Vehicles & Intelligent Infrastructure at Urban Junctions



2017 –2020

With support from



by decision of the German Bundestag



Next Generation Sensor Data Fusion (Radar + Stereocam) in Complex City Scenarios

Projects - Urban Automated Driving

DK4.0

Digitaler Knoten 4.0

2016 –2019

With support from

Federal Ministry of Transport and Digital Infrastructure

by decision of the German Bundestag

Deutsches Zentrum für Luft- und Raumfahrt (DLR)

Technische Universität Braunschweig

AVL

VOLKSWAGEN

OFFIS

SCHLOTHAUER & WAUER Ingenieurgesellschaft für Straßenverkehr

nordsys

ifuse

2017 –2020

With support from

Federal Ministry for Economic Affairs and Energy

by decision of the German Bundestag

BOSCH

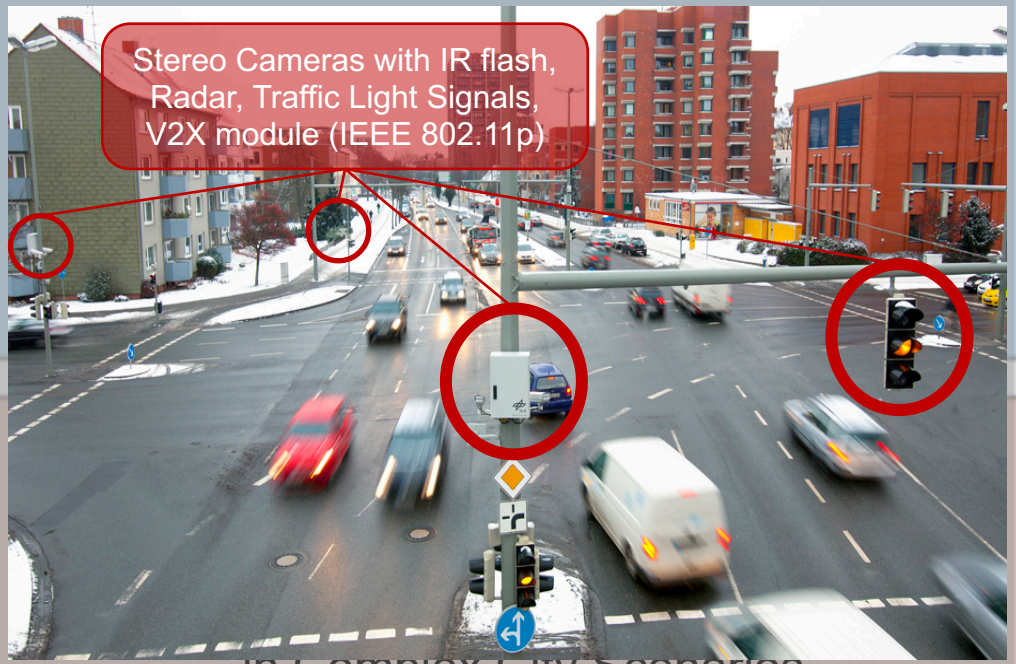
Technische Universität Braunschweig

Leibniz Universität Hannover

dSPACE

Infineon

Dream Chip

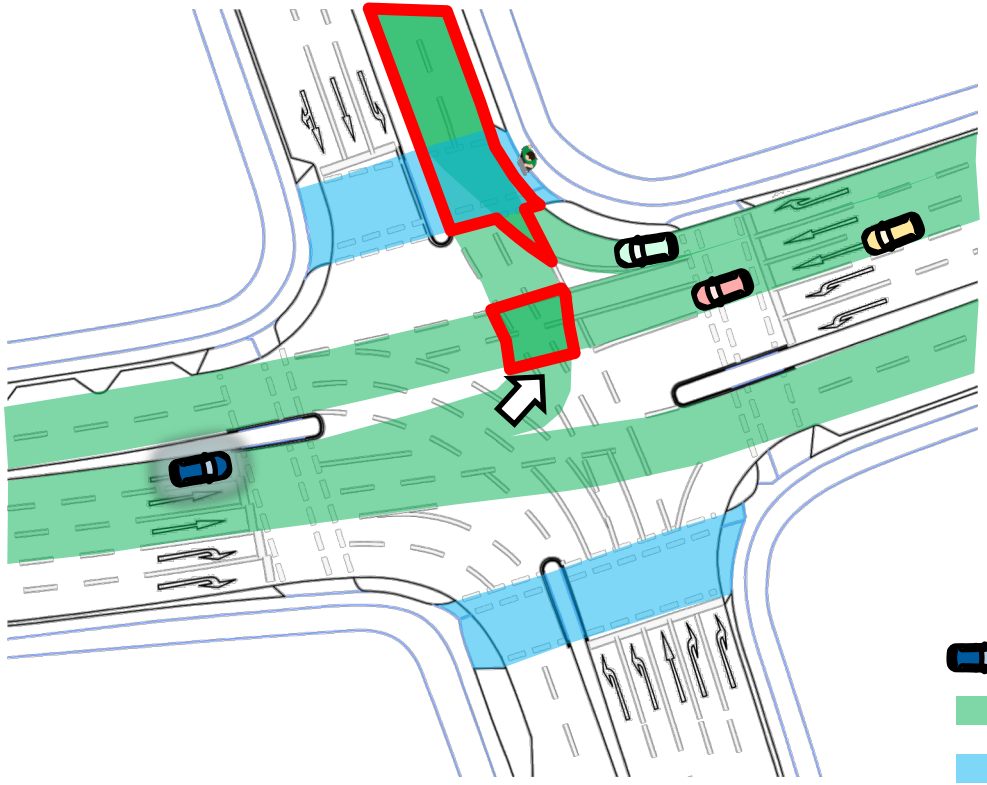


in Complex City Scenarios

Test field: AIM Research Intersection in Braunschweig

(operated by DLR – German Aerospace Centre)

Example for a Complex Scenario: Left Turn



Automated Vehicle
Motorized Traffic
Cyclist/Pedestrian (VRU)

Research Vehicles



Testing and Engineering of Automated driving SYstems



Testing of Integrated Automation and MOnitoring Systems

Driving Functions

Environment Model:
Where are the other road users?
(previously / currently / predicted)



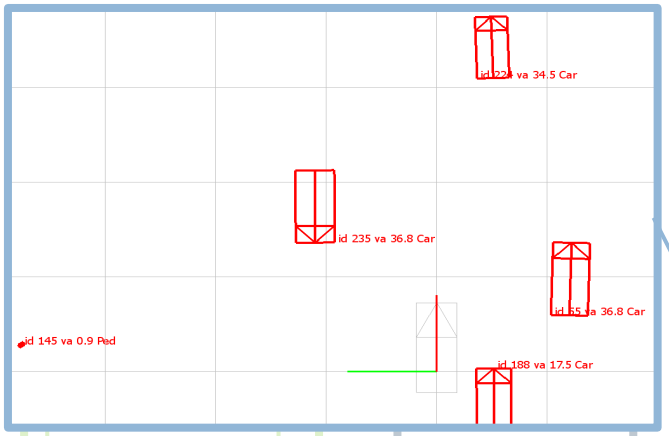


Planning & Decision:
At which point in time do I start or stop at the intersection?

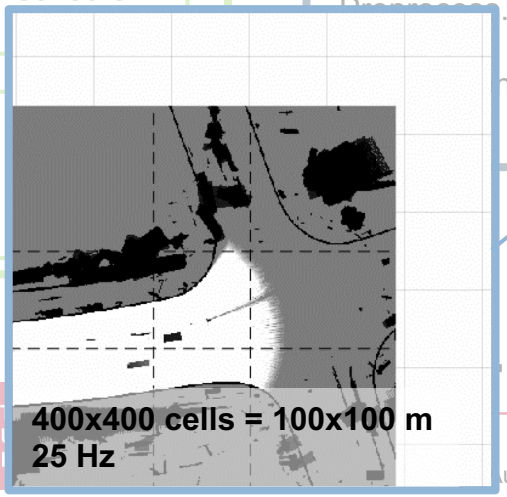
Trajectory & Control:
How to drive safely and comfortably on complex road geometries?



Architecture & Environment Model



sensors



Scene & Context model

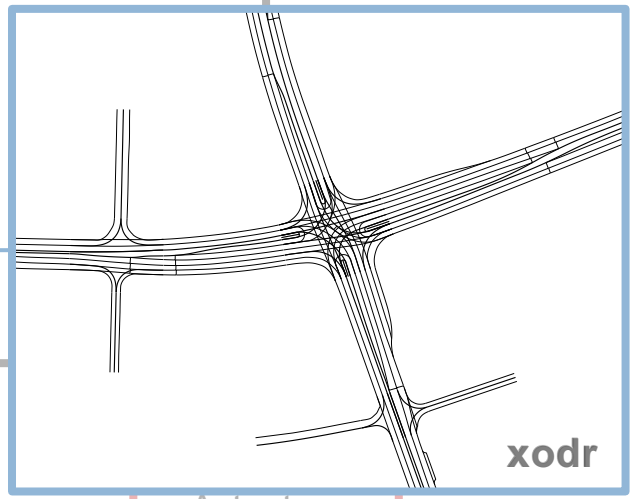
Feature cluster

Objects

Road network

Grid map

Ego vehicle motion



Actuators

Localization

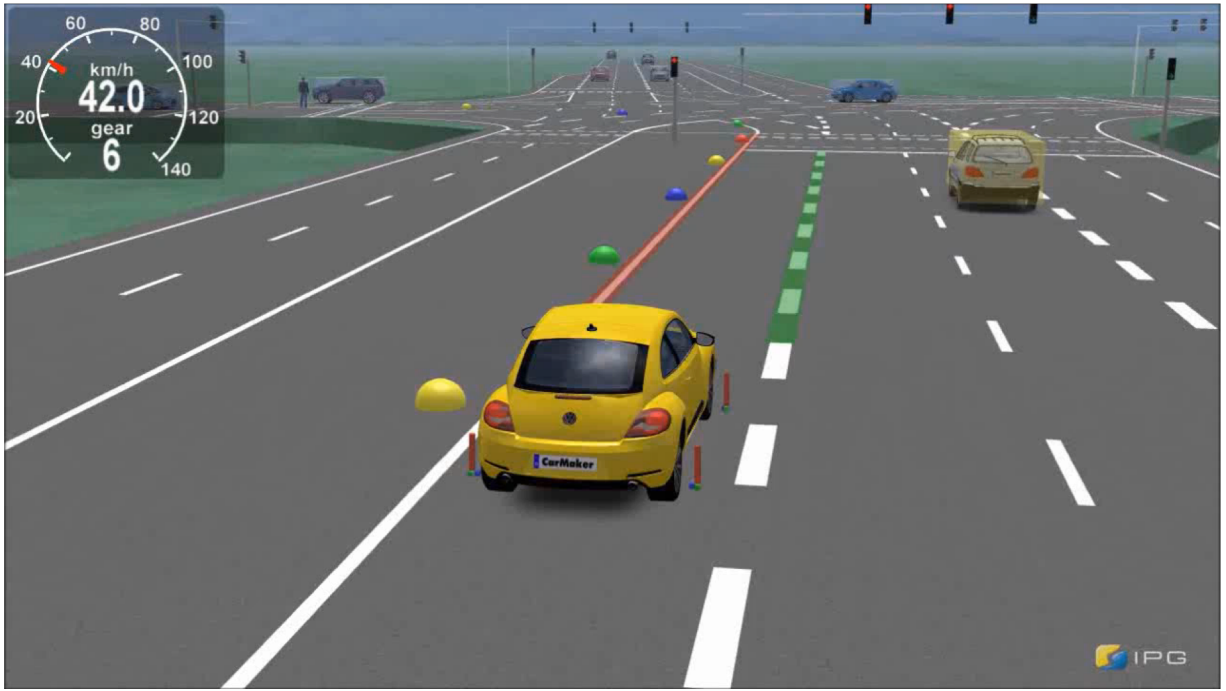
Planning & Decision

Phases of crossing the intersection:

1. Turn Lane
2. Traffic Signal
3. Entering the Inner Intersection Area
4. Right of Way Traffic
5. Vulnerable Road Users

Decision based on **checks of conflict zones**

Using Simulation for Modeling Scenario & Functions (IPG CarMaker)



TRAJECTORY

Map Parser
OpenDrive (xodr)

Precise, global position

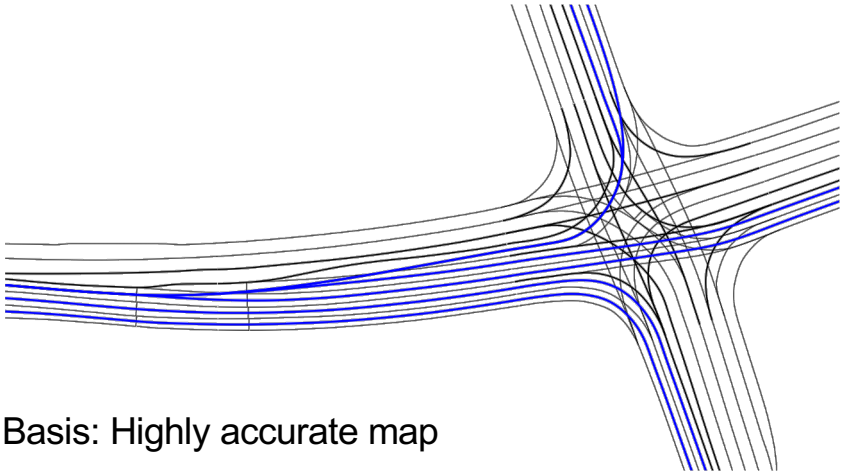
Map Association
Road, lane, lane-section

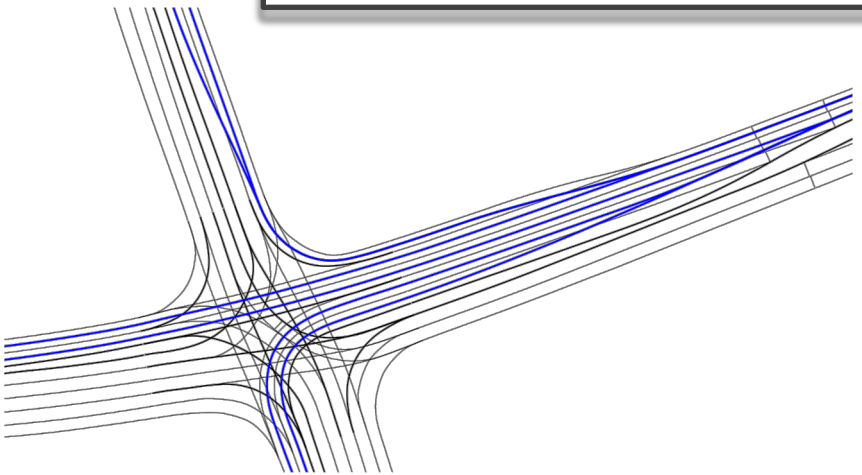
Target road

Navigation
Road to road
Lane to lane

Planning Ideal Trajectory

- Map reference points
- Determining „critical path“
- Lane changes
- Splines
- Curvature and safe speed



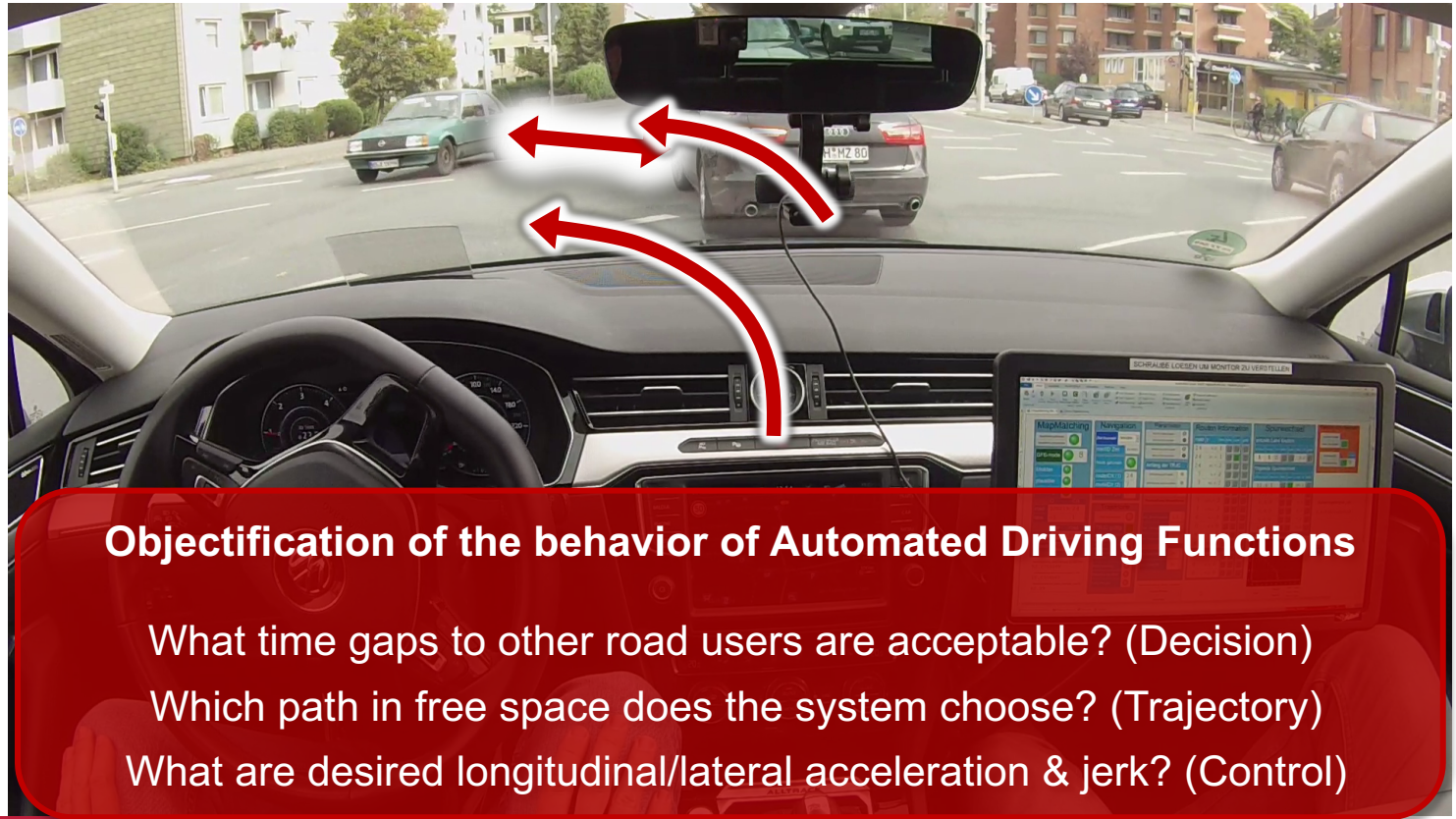


Basis: Highly accurate map

How does the driver want to be driven?



How does the driver want to be driven?



Objectification of the behavior of Automated Driving Functions

What time gaps to other road users are acceptable? (Decision)

Which path in free space does the system choose? (Trajectory)

What are desired longitudinal/lateral acceleration & jerk? (Control)

THANK YOU!

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