Analysis of automated driving diffusion: Potential diffusion paths into the German Market

Dr. Christine Eisenmann

SIP-adus Meeting, 12/11/2020

In collaboration with:

Dr. Christian Winkler, Dennis Seibert, Nina Thomsen (DLR)

Prof. Tobias Kuhnimhof, Michael Schrömbges (RWTH)

Dr. Thomas Meissner, Dr. Peter Phleps (BMW)

Wissen für Morgen

Research objectives and contents

Research objectives

Diffusion of connected and automated driving (CAD) (focus: car market)

Changes in **car ownership**, **individual travel behaviour** and **collective travel demand**

Potential diffusion paths

The private autonomous car

Autonomous Mobility as a Service MaaS (resp. ODM, ridehailing)

Research objectives and contents
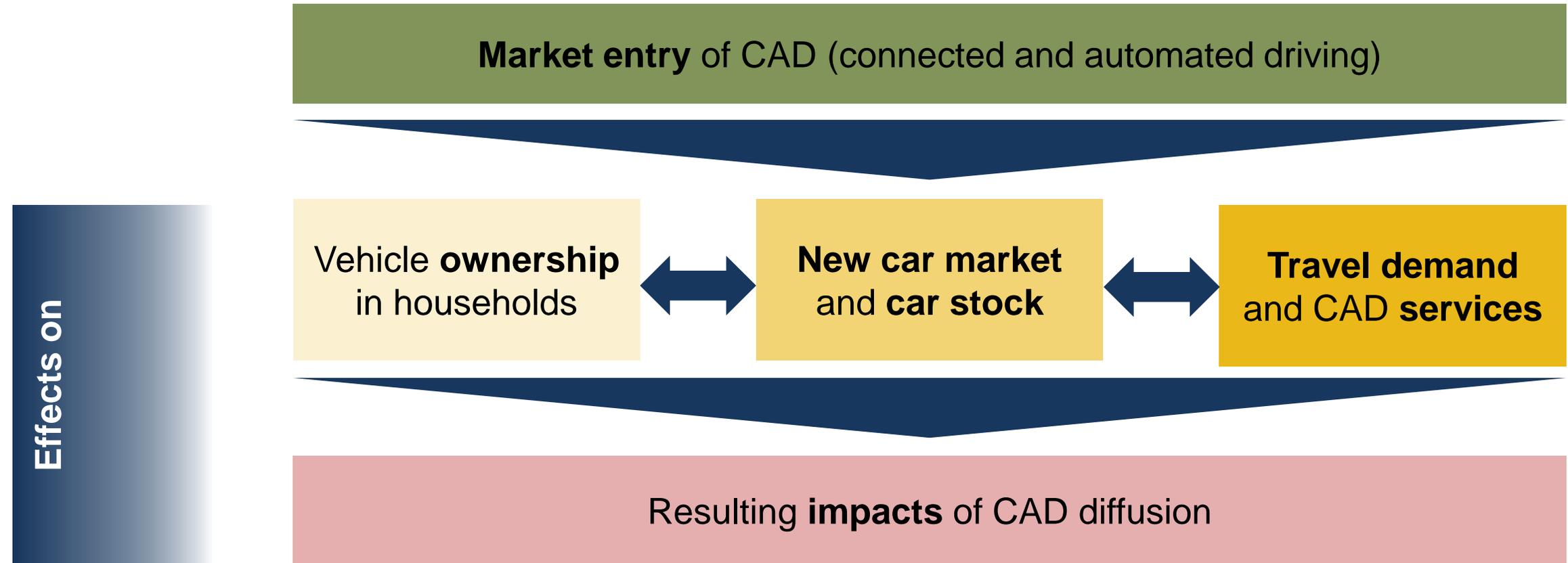
Potential diffusion paths

Research questions in this regard

- How do those diffusion paths affect car ownership, the new car market, the car stock and travel demand?

- Which effects do the different diffusion paths have on transport sustainability and on the car industry?

- Is the narrative (told in Germany) realistic that private cars will be replaced by automated services and that automation will lead to a reduction of the car fleet? And if so, under which conditions?

To analyse CAD diffusion from a quantitiative perspective, a model chain is being implemented

Market entry of CAD (connected and automated driving)

Effects on

Vehicle **ownership** in households

⟷

New car market and **car stock**

⟷

Travel demand and CAD **services**

Resulting **impacts** of CAD diffusion

Key questions on market entry

Market entry of CAD (connected and automated driving)

Effects on

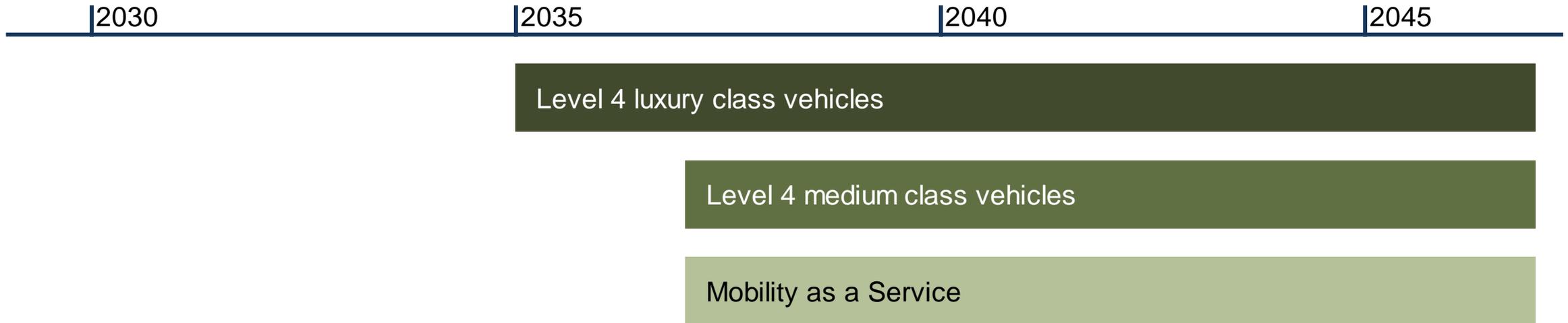Vehicle ownership in households

new car market and car stock

Travel demand of CAD vehicles

When will automated cars be available on the German market?

When will we have automated MaaS vehicles on the streets?

Resulting **impacts** of CAD diffusion

Model assumptions on the entry of level 4 automated vehicles into the German market are derived from interviews with industry experts

| 2030 | 2035 | 2040 | 2045 |

Level 4 luxury class vehicles

Level 4 medium class vehicles

Mobility as a Service

Key questions on vehicle ownership in households

Market entry of CAD (connected and automated driving)

Effects on

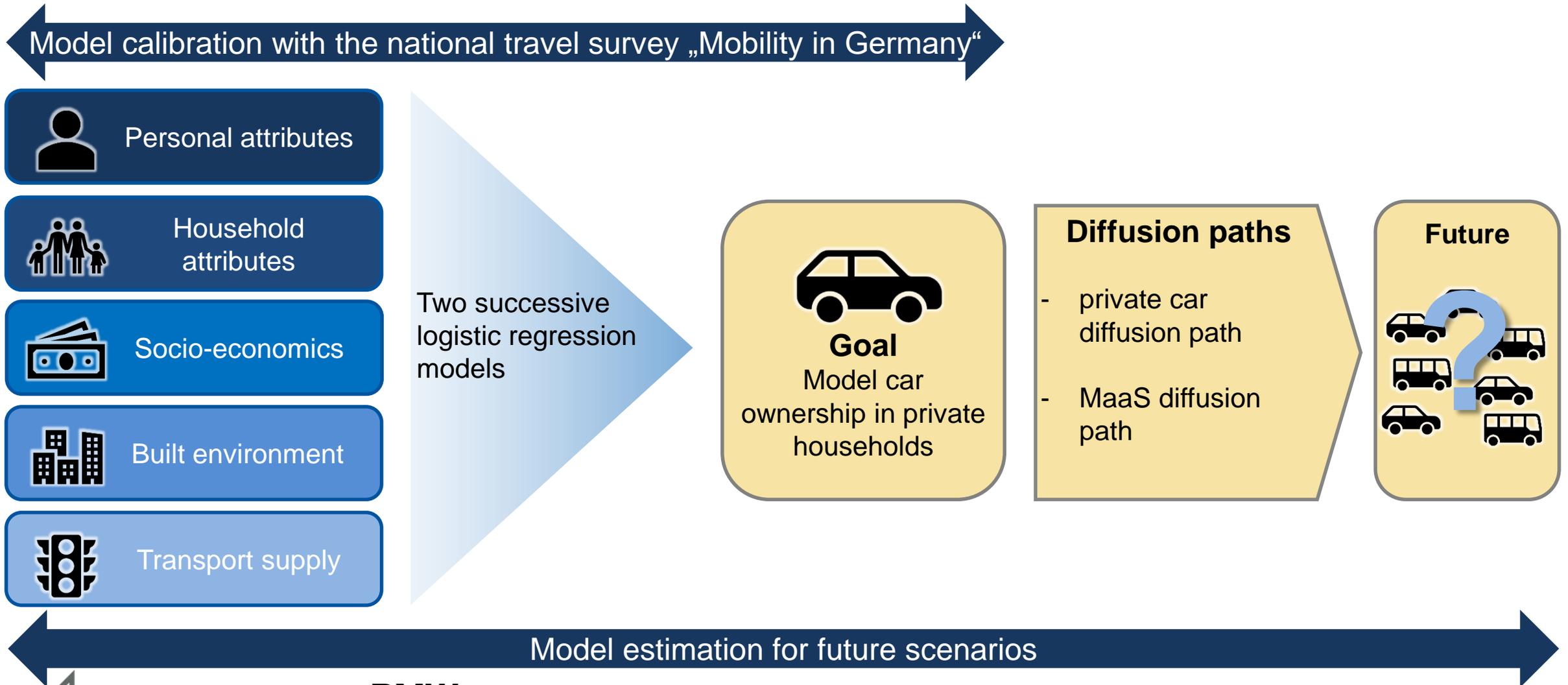| Vehicle **ownership** in households | New car market and **car stock** | Travel demand and CAD **services** |

How does automation affect the car ownership decisions of private households on (i) the private cars diffusion path or (ii) the MaaS diffusion path?

Under which conditions might the availability of MaaS lead to household decisions against an own car?

A discrete choice model for car ownership in households is being developed

Model calibration with the national travel survey „Mobility in Germany"

- Personal attributes
- Household attributes
- Socio-economics
- Built environment
- Transport supply

Two successive logistic regression models

Goal
Model car ownership in private households

Diffusion paths

- private car diffusion path

- MaaS diffusion path

Future

Model estimation for future scenarios

Key questions on the new car market and the vehicle stock

Market entry of CAD (connected and automated driving)

Effects on

Vehicle **ownership**
in households

New car market
and **car stock**

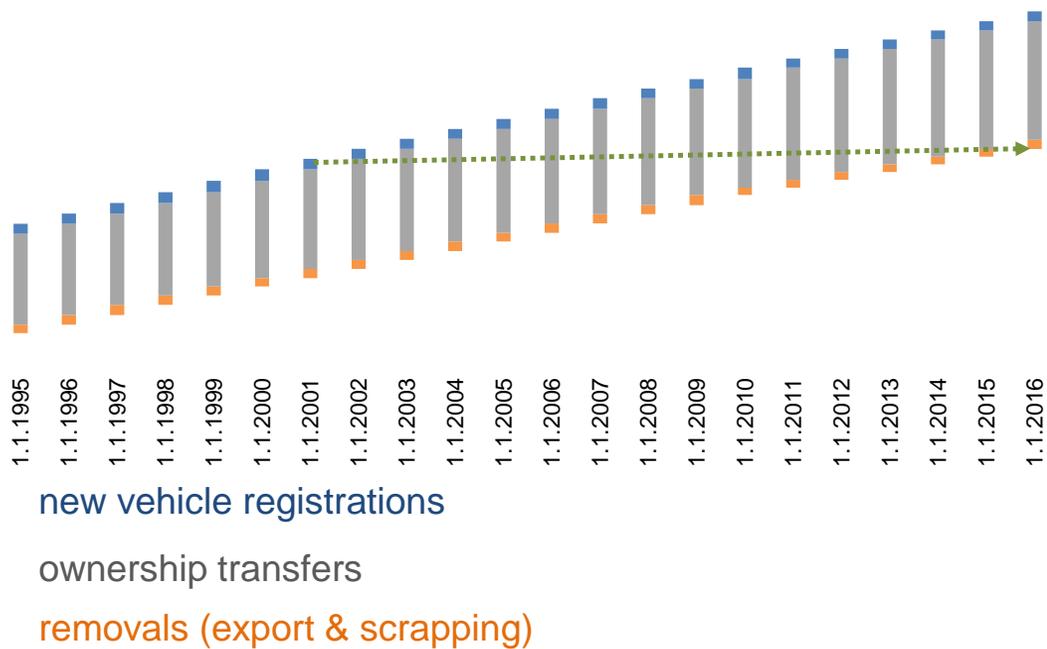**Travel demand**
and CAD **services**

How many automated cars will we have in the German new car market and car stock in 2030, 2040 and 2050 at (i) the private car diffusion path or (ii) the MaaS diffusion path?
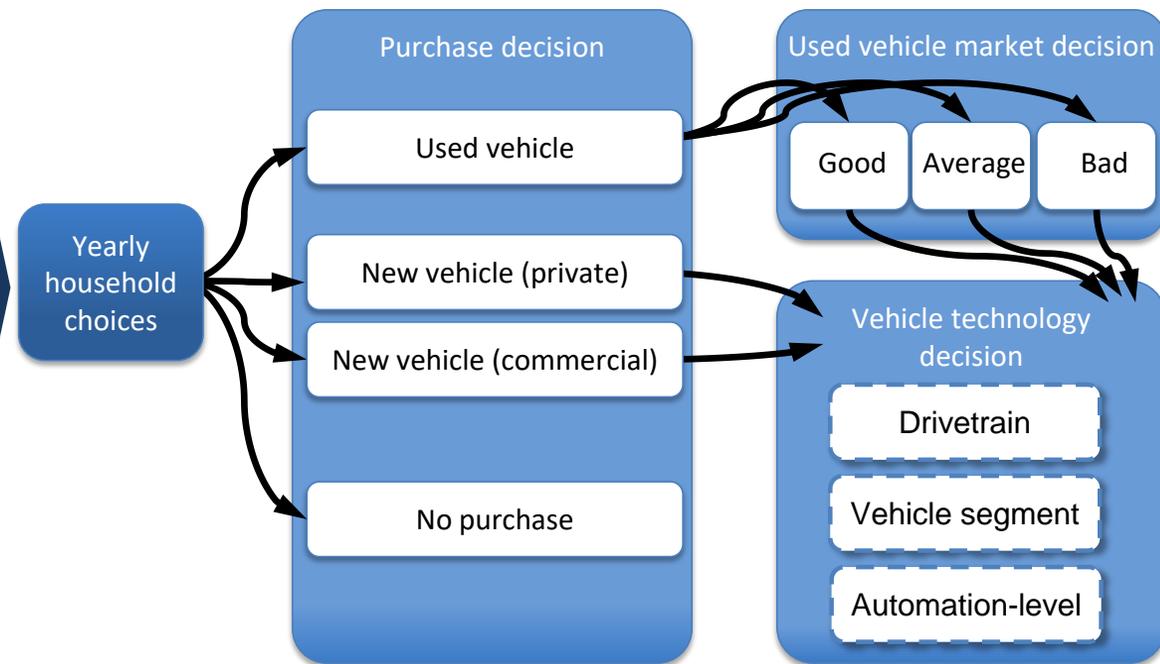
How will automation affect the used car market?

An agent-based vehicle stock model is being used to study the effects of automation to the new car market and the vehicle stock

The German vehicle stock is modeled dynamicly

new vehicle registrations

ownership transfers

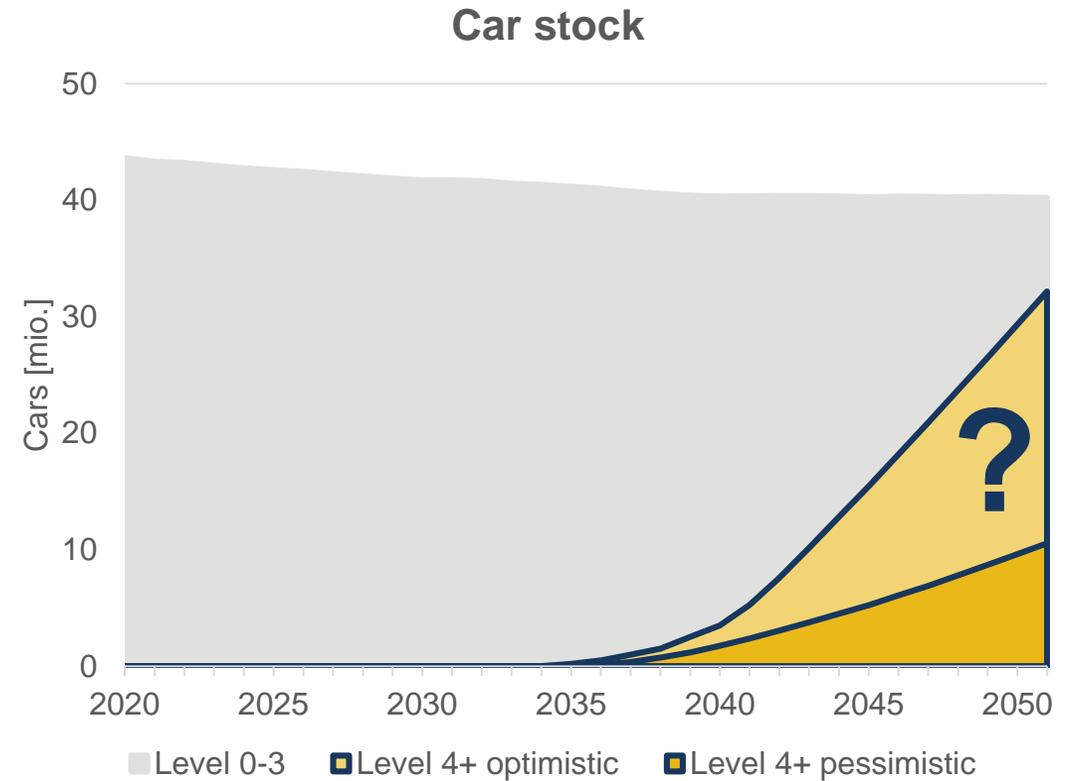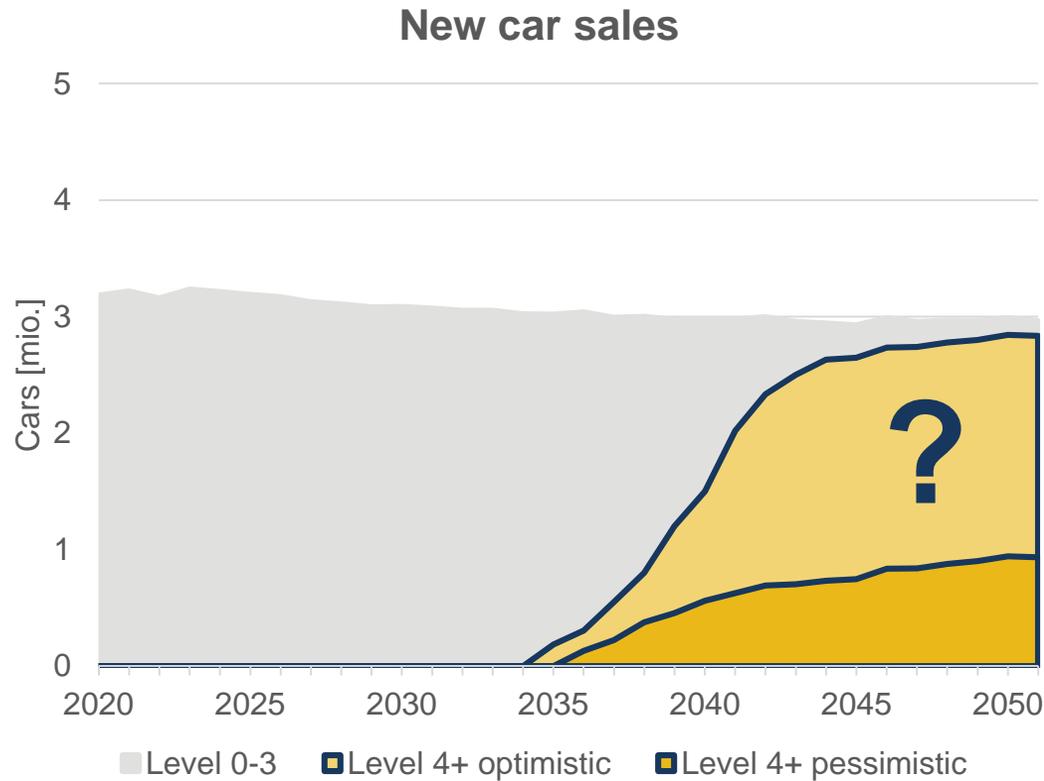removals (export & scrapping)

Annual, agent-based simulation of household choices

Ac rising demand for automated cars on the new car market has a ladded effect on the car stock

Exemplary, preliminary results for the private car diffusion path

Key questions on travel demand and CAD services

Market entry of CAD (connected and automated driving)

Effects on

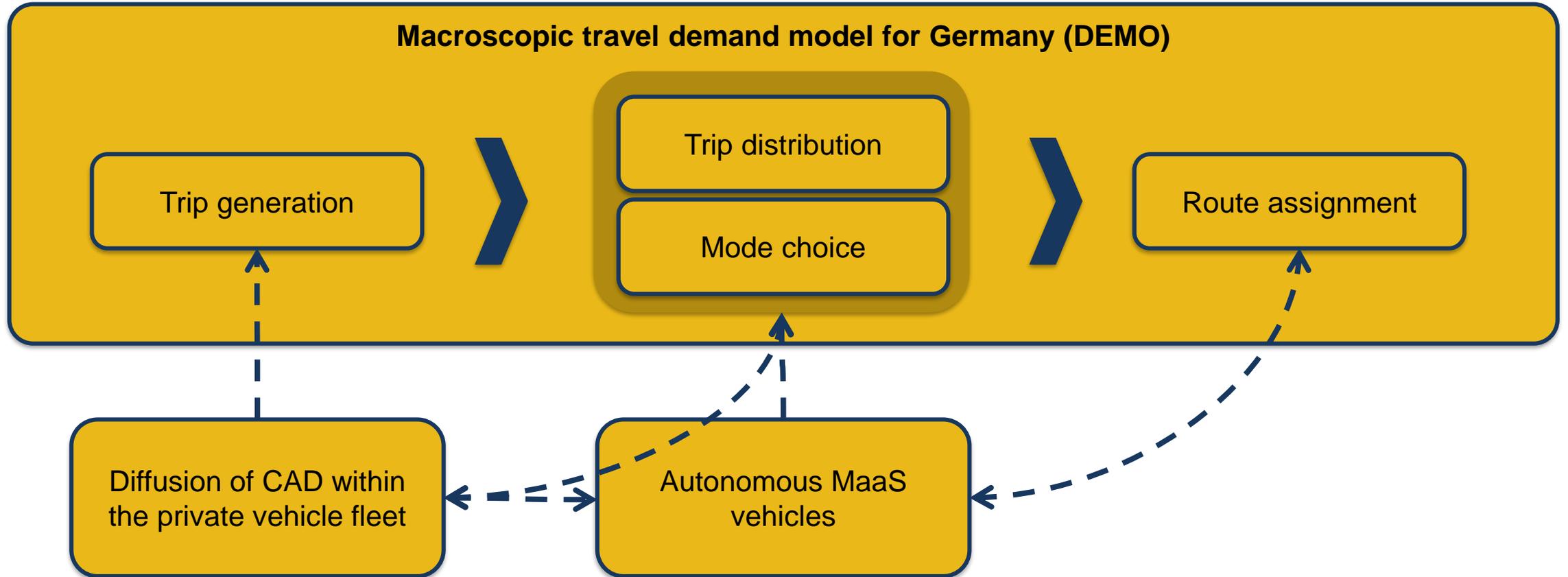Vehicle **ownership** in households ⟷ **New car market** and **car stock** ⟷ **Travel demand** and CAD **services**

How will future travel mode choice change on (i) the private car diffusion path or (ii) the MaaS diffusion path?

How does the operation of MaaS fleets work?

DLR | ISB Chair and Institute of Urban and Transport Planning | RWTH AACHEN UNIVERSITY | BMW GROUP

A german-wide transport demand model is being extended, to analyze the impacts of automation on travel demand

Macroscopic travel demand model for Germany (DEMO)

Trip generation

Trip distribution

Mode choice

Route assignment

Diffusion of CAD within the private vehicle fleet

Autonomous MaaS vehicles

In the travel demand model MaaS is being applied in large cities

MaaS will be available in cities with more than 100,000 inhabitants (marked in orange)
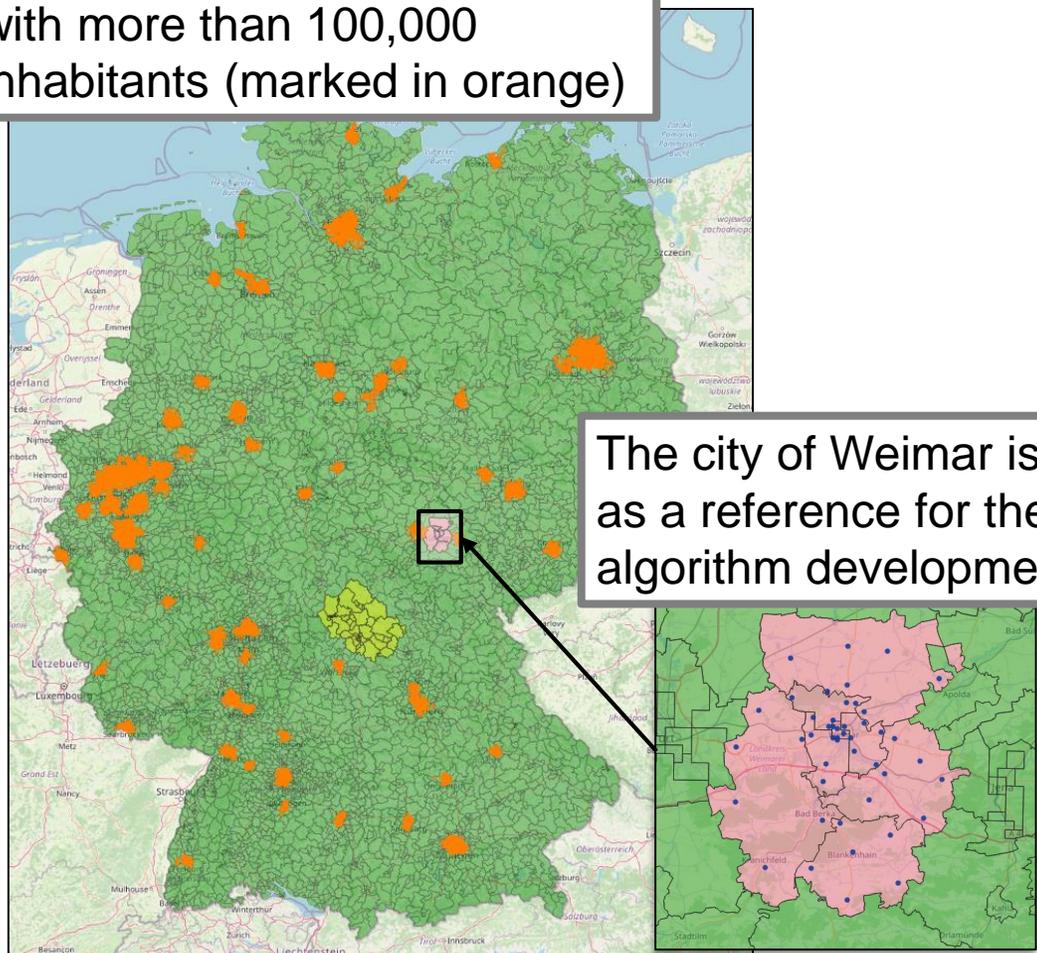
The city of Weimar is used as a reference for the algorithm development

Exemplary results on MaaS for the Weimar region

Modal Share	MaaS fleet	Daily mileage	Occupancy rate
	[vehicles per 1,000 inhabitants]	[km per vehicle]	[passengers per trip]
7 %	3.8	269	1.1
11 %	5.2	261	1.3

- Only 3 to 6 MaaS vehicles per 1,000 inhabitants are needed to enable a MaaS modal share of 7% to 11%

- MaaS vehicles cover about eight times more distance per day than private cars

- The occupancy rate indicates that only a few MaaS trips are shared

DLR

Key questions on resulting impacts of CAD (at a later stage of the project)

Market entry of CAD (connected and automated driving)

Effects on

What are the resulting effects of CAD diffusion (on transport, the environment, industry) at (i) the private car diffusion path or (ii) MaaS diffusion path?

Resulting **impacts** of CAD diffusion

Conclusion and outlook

- With this project we are applying a unique and solid model chain to adequately display two likely diffusion paths of automated vehicles into the German market and their effects on sustainability and the industry

- The applied model chain enables us to shed light into the discussion (in Germany), whether and under which conditions automation might lead to a reduced car fleet.

- The Japanese-German collaboration:
    - The joint reflection of assumptions, scenarios and model approaches is very beneficial for the project activities.
    - Comparisons on CAD diffusion in Japan and Germany given structural similarities but also geographical, social and regulatory differences are helpful for the development and implementation of CAD

- A major question remains as to what impact the current development and the corona pandemic will have on the probability of either of the diffusion paths occurring

Thank you for your attention!

Dr. Christine Eisenmann
DLR Institute of Transport Research
Christine.eisenmann@dlr.de

Wissen für Morgen