

FSD Fahrzeugsystemdaten GmbH

Central Agency for PTI

Neural Networks, Deep Learning & Applications – FSD Project

Marina Dolokov



Dresden, 28th April 2025

Agenda

- 1. FSD Central Agency**
- 2. Brake Inspection**
- 3. Project Tasks**



1 | FSD Central Agency



Founding of FSD

4 October 2004

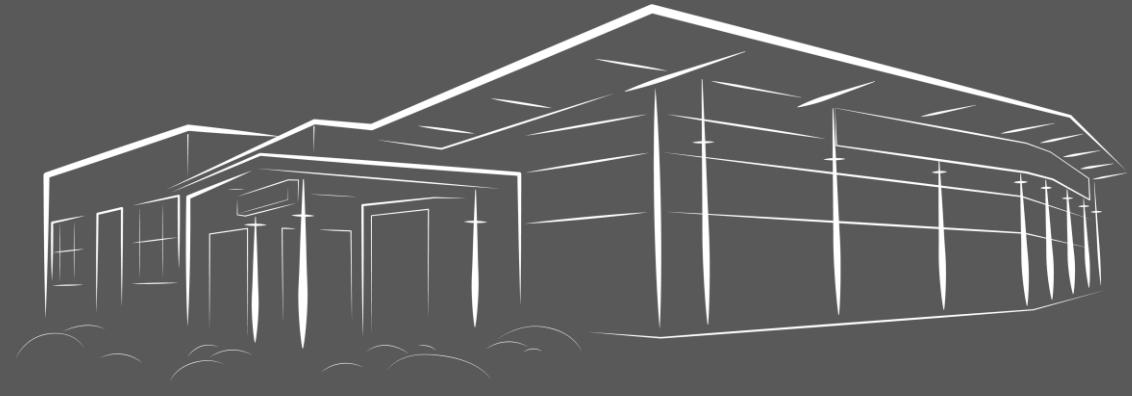
Central Agency for PTI

10 May 2012



Head Office in Dresden

2 locations

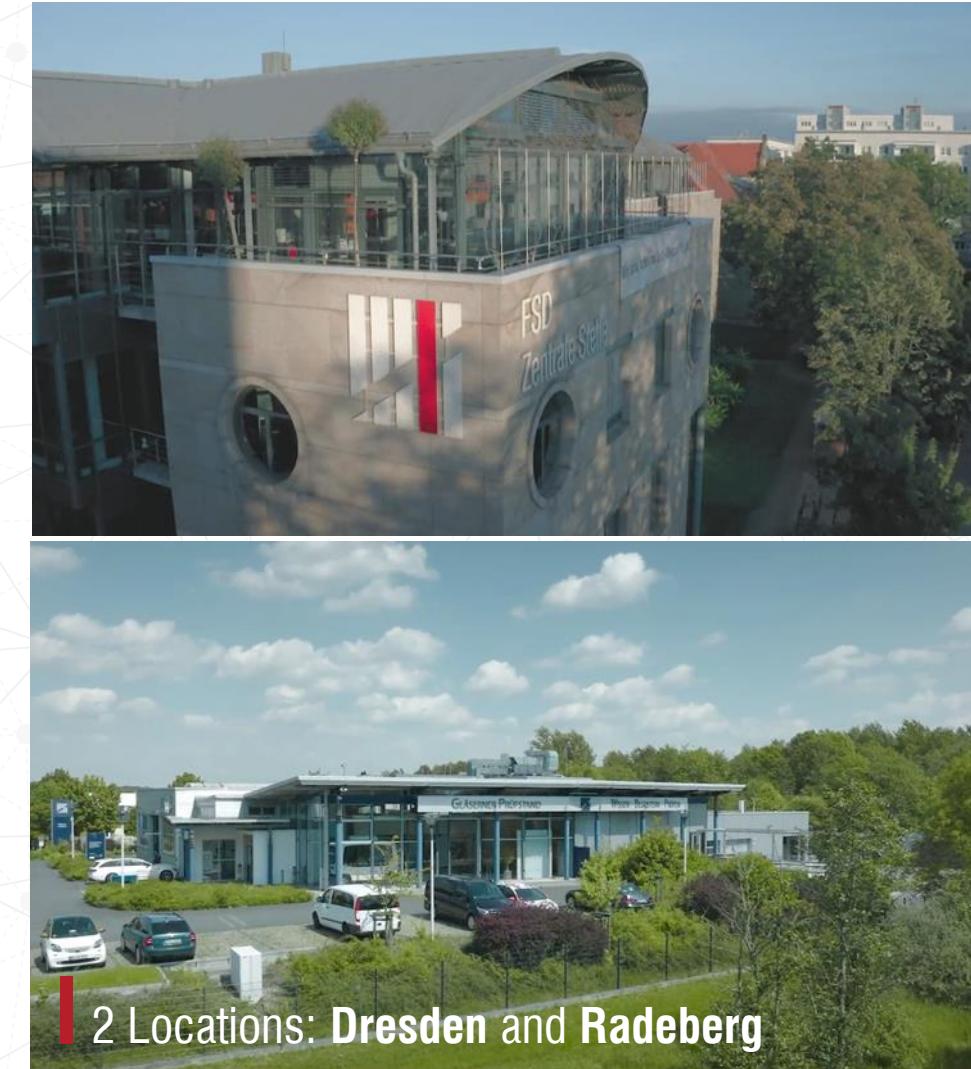
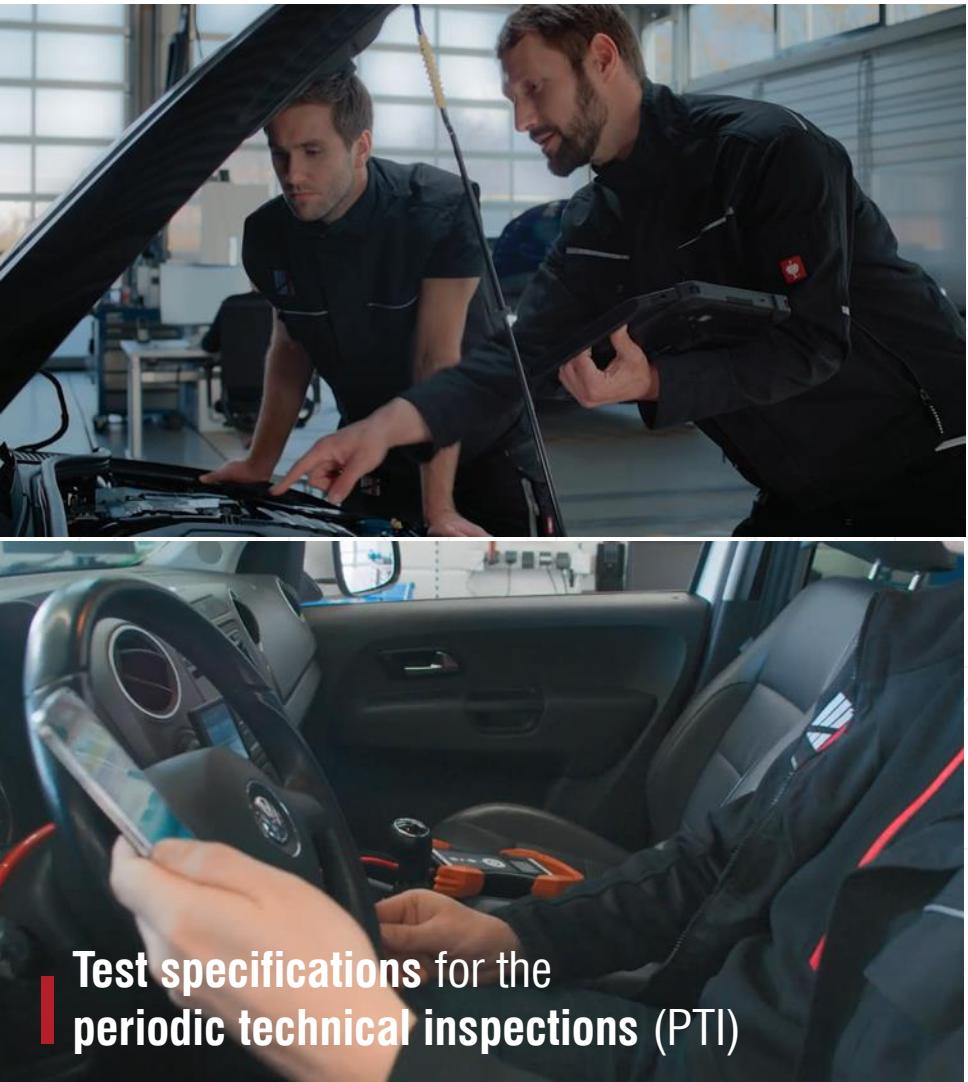


Test Laboratory in Radeberg

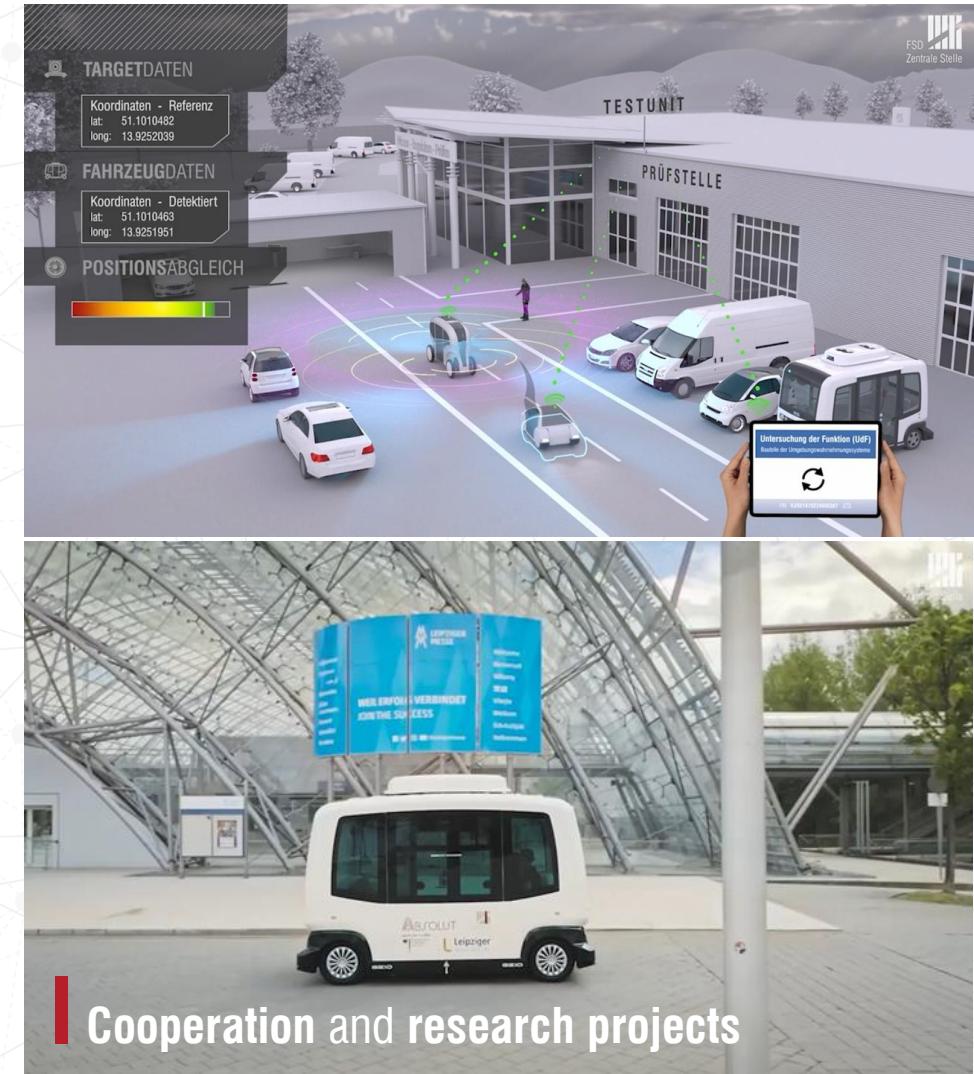


Around 210 employees

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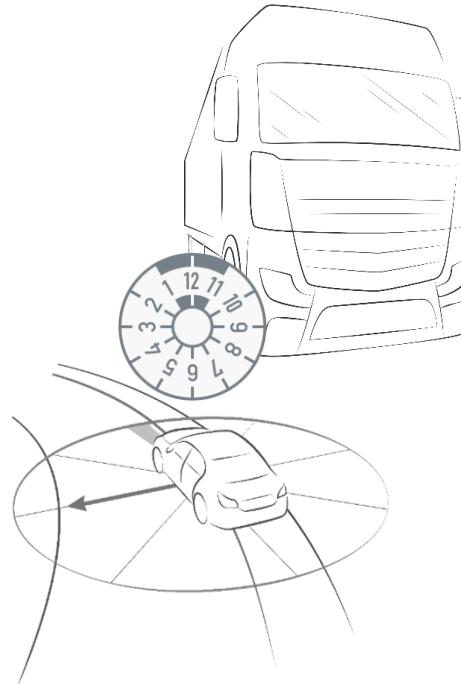
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Development of the periodic technical inspection (PTI)

Tasks

- Development and provision of vehicle test specifications**
for the periodic technical inspection (PTI)



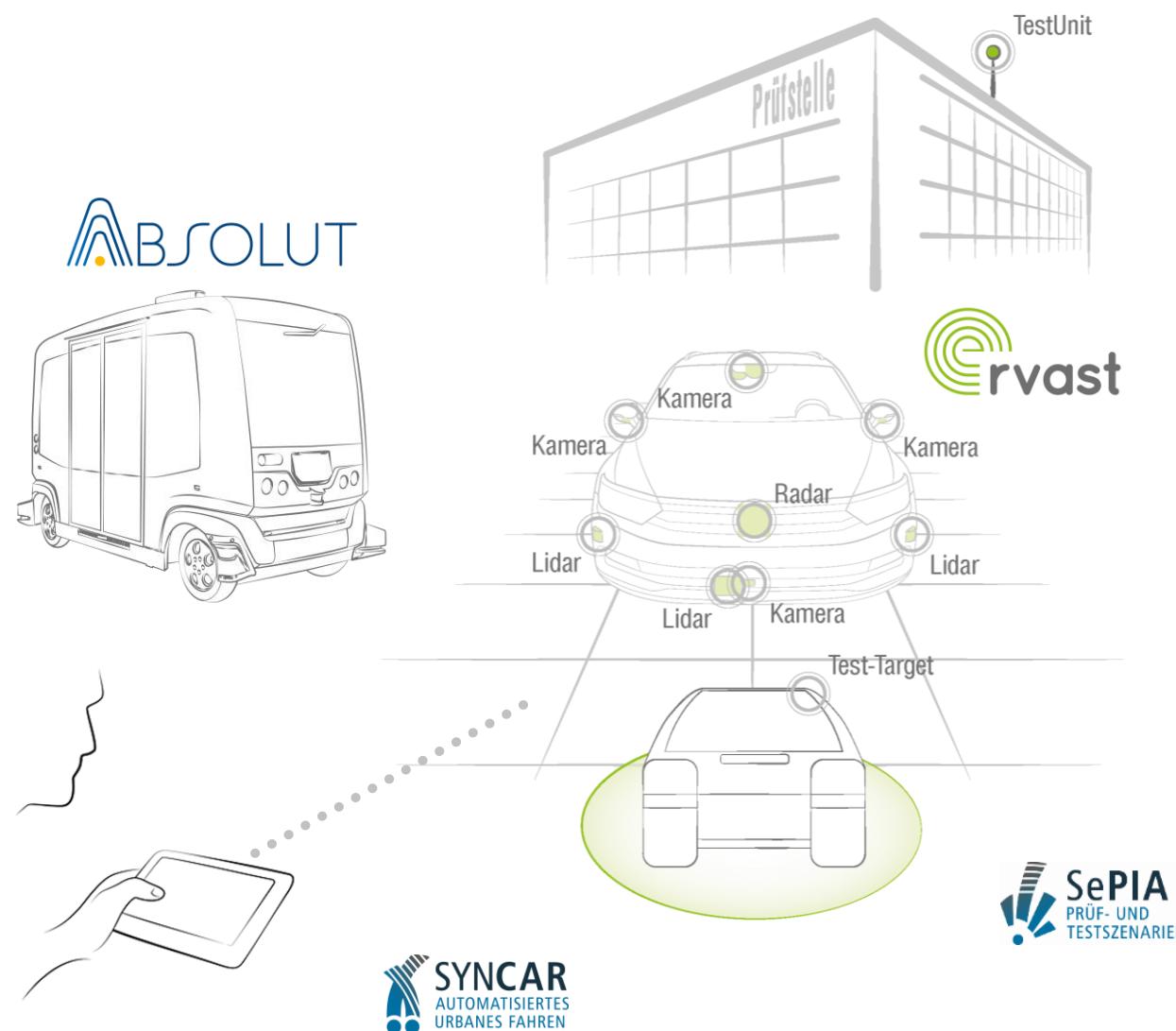
* in accordance with Section 6.1.2 I) and m) German Road Traffic Act (StVG)

** in accordance with Section 29 in conjunction with Appendices VIIa and VIIe of the German Road Traffic Regulations (StVZO) and Directive 2014/45/EU

Development of the periodic technical inspection (PTI)

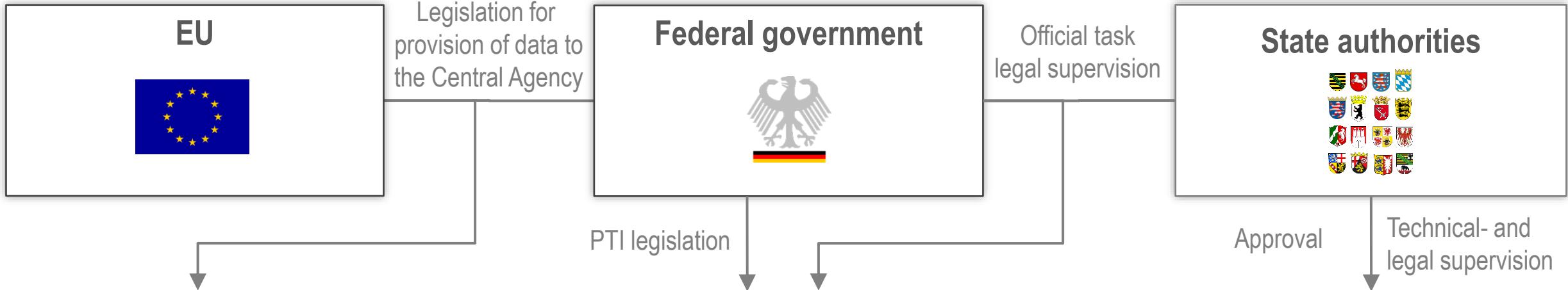
Tasks

- **Research and Development** of modern and innovative test and inspection technologies for future PTI

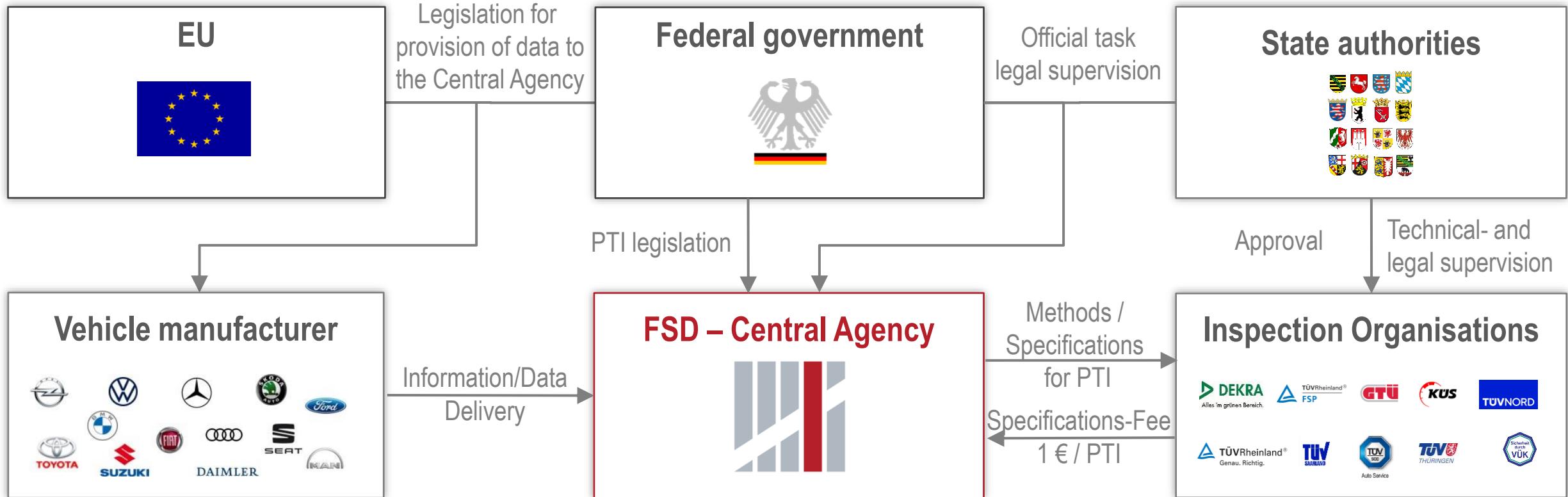


* in accordance with Section 6.1.2 l) and m) German Road Traffic Act (StVG)

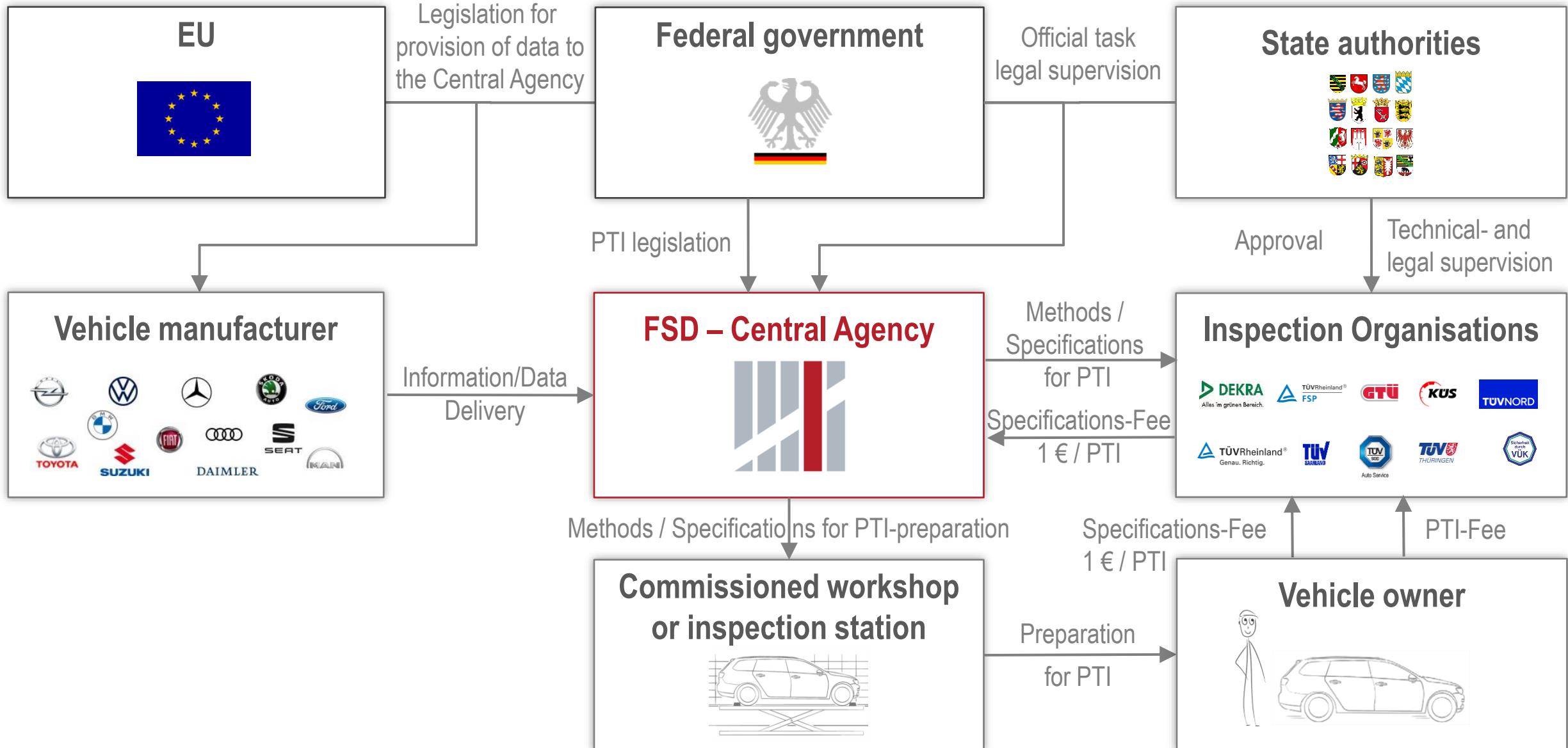
FSD – Central Agency for PTI in Germany (Nonprofit organization) Organisation



FSD – Central Agency for PTI in Germany (Nonprofit organization) Organisation

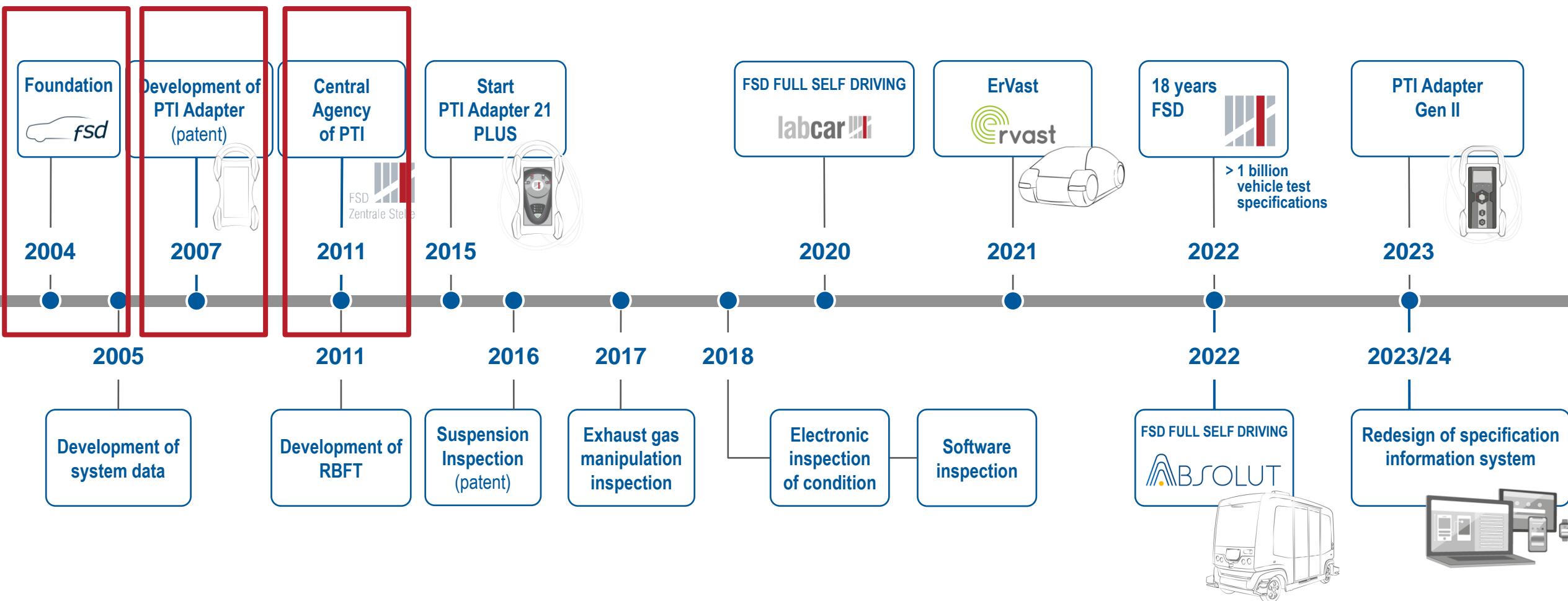


FSD – Central Agency for PTI in Germany (Nonprofit organization) Organisation



FSD – Central Agency for PTI in Germany

Important milestones

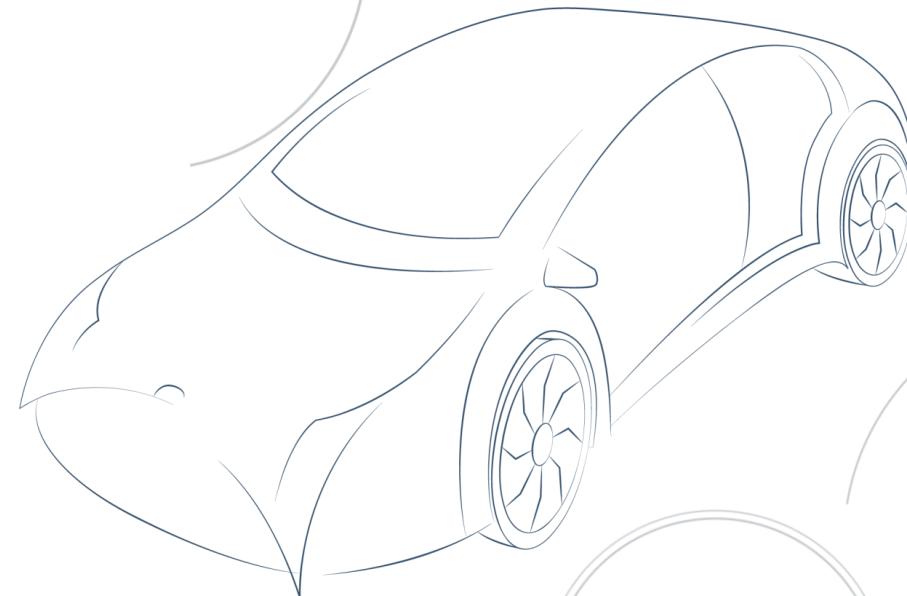


Challenges in the electronic periodic technical inspection

**59 million
motor vehicles**
on German roads.¹

Introduction of
**OBD interface
2001/2004**

Partly proprietary
diagnostic protocols of
> 40 OEMs

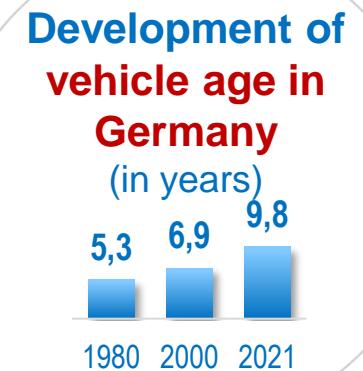


**Approx. 50
relevant
safety
systems**
in accordance with PTI
Directive

**>2,000
vehicle models**
with diagnostically relevant
differences
(passenger cars, motorcycles
and commercial vehicles)
(FSD models)

Each vehicle is
subject to a
**PTI 5 – 10
times**

**50 – 100
controllers**
in a modern
passenger car



¹ <https://de.statista.com/statistik/kategorien/kategorie/16/themen/129/branche/fahrzeuge-strassenverkehr/#overview>

Testing of specifications as part of the electronic periodic technical inspection

Overview of todays test and inspection methods



Overview of defects
(defect catalogue)



Specifications for
systems (installation,
condition)



Specifications for
service braking
system



Inspection of
engine management



Specifications for
eCall



Speed limiter



Suspension
damping



Braking
performance



Decelerometer



In-Vehicle
information



Inspection
instructions



Additional
information



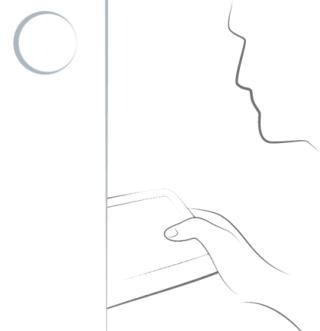
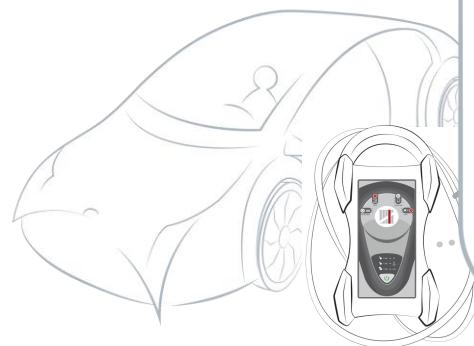
Location
information



Serial tyres



Technical data

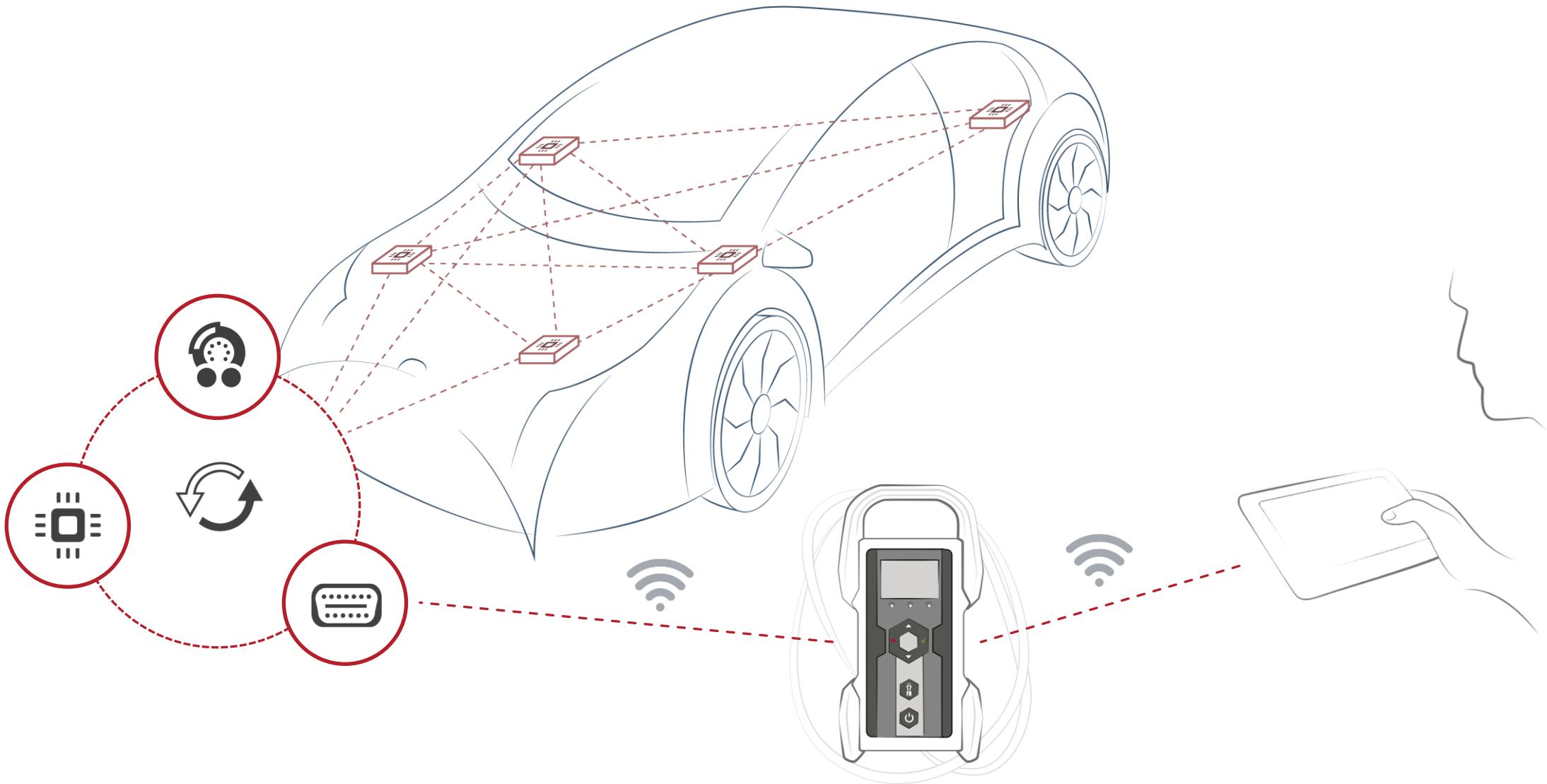




2 | Brake Inspection

Introduction on Electric Vehicles

Inspection using the electronic vehicle interface



Electronic periodic technical inspection (PTI)

PTI Adapter as a central tool



Electronic periodic technical inspection (PTI)

PTI Adapter as a central tool

... supports officially recognised appraisers and test engineers when inspecting the vehicles with regard to



fitment,



function,

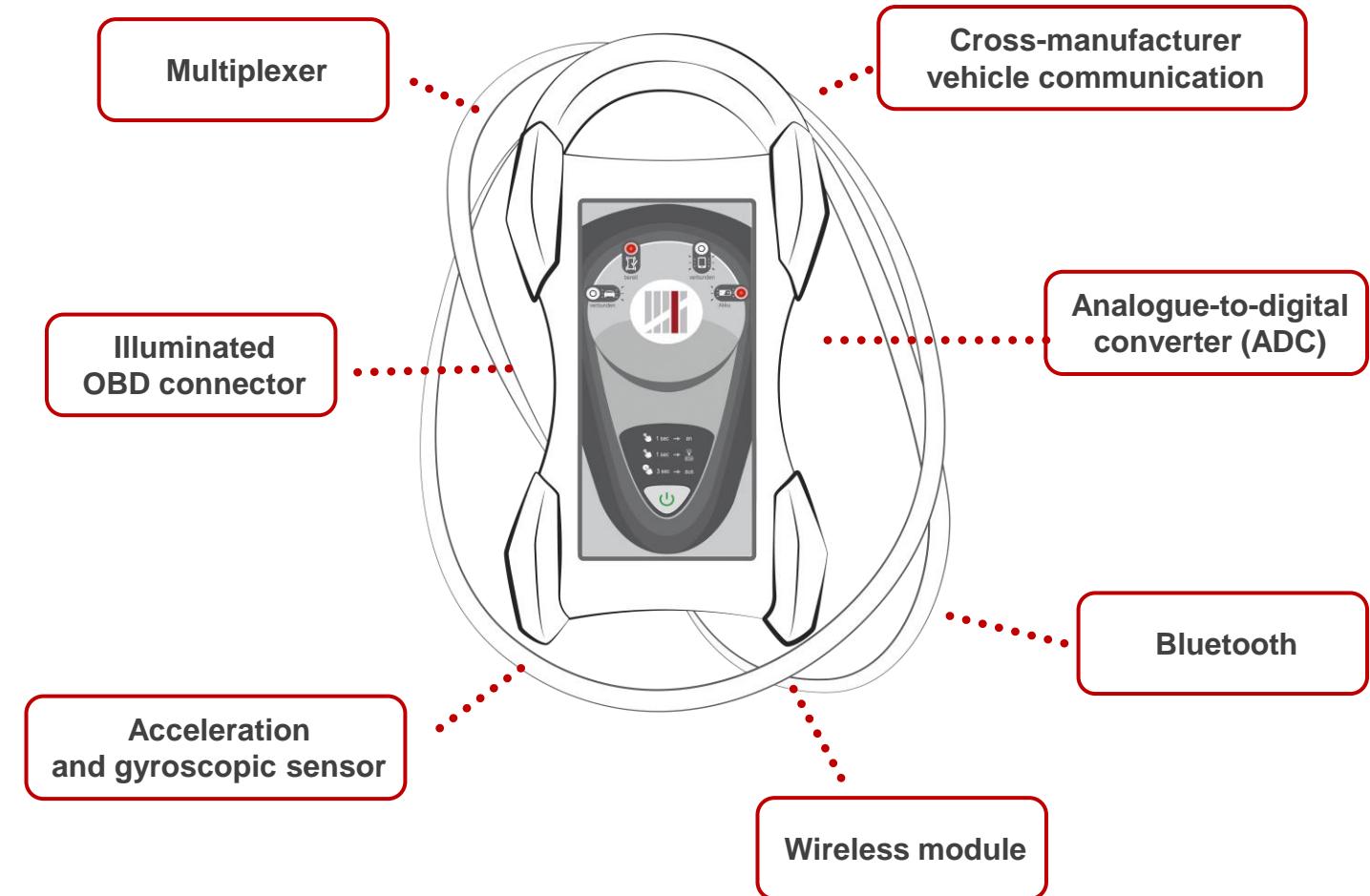


effectiveness and



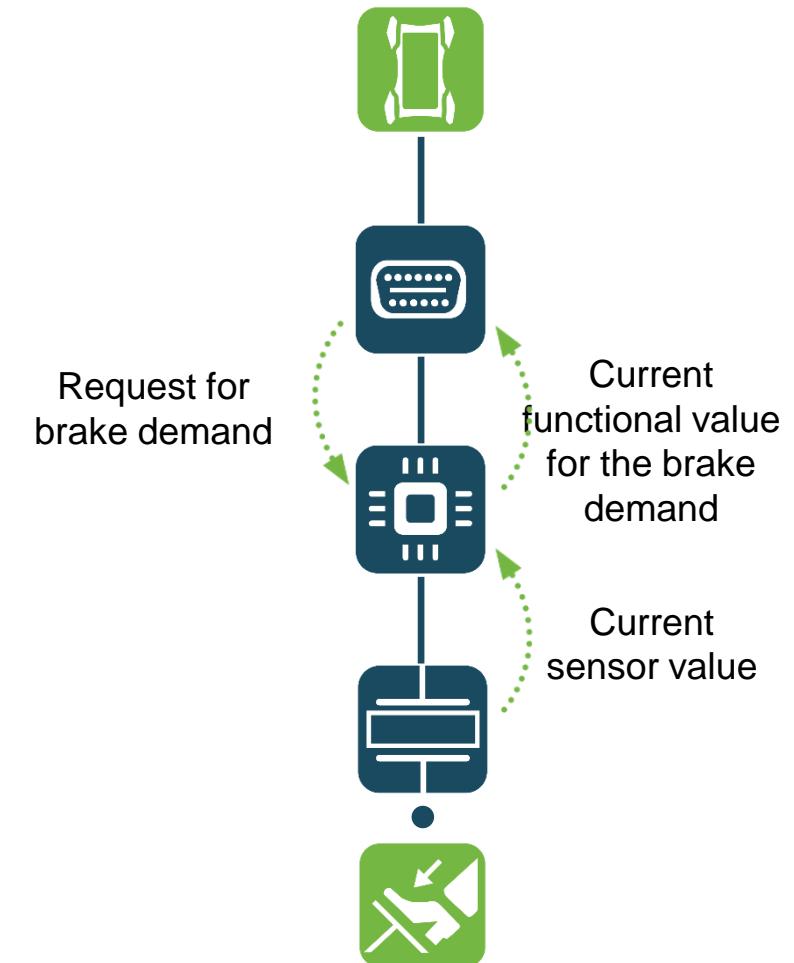
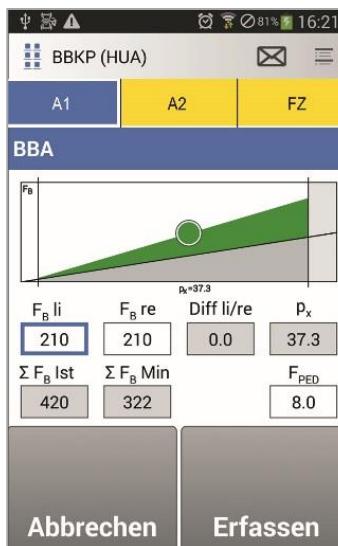
condition

of their components and systems.



Use of the electronic vehicle interface in the PTI

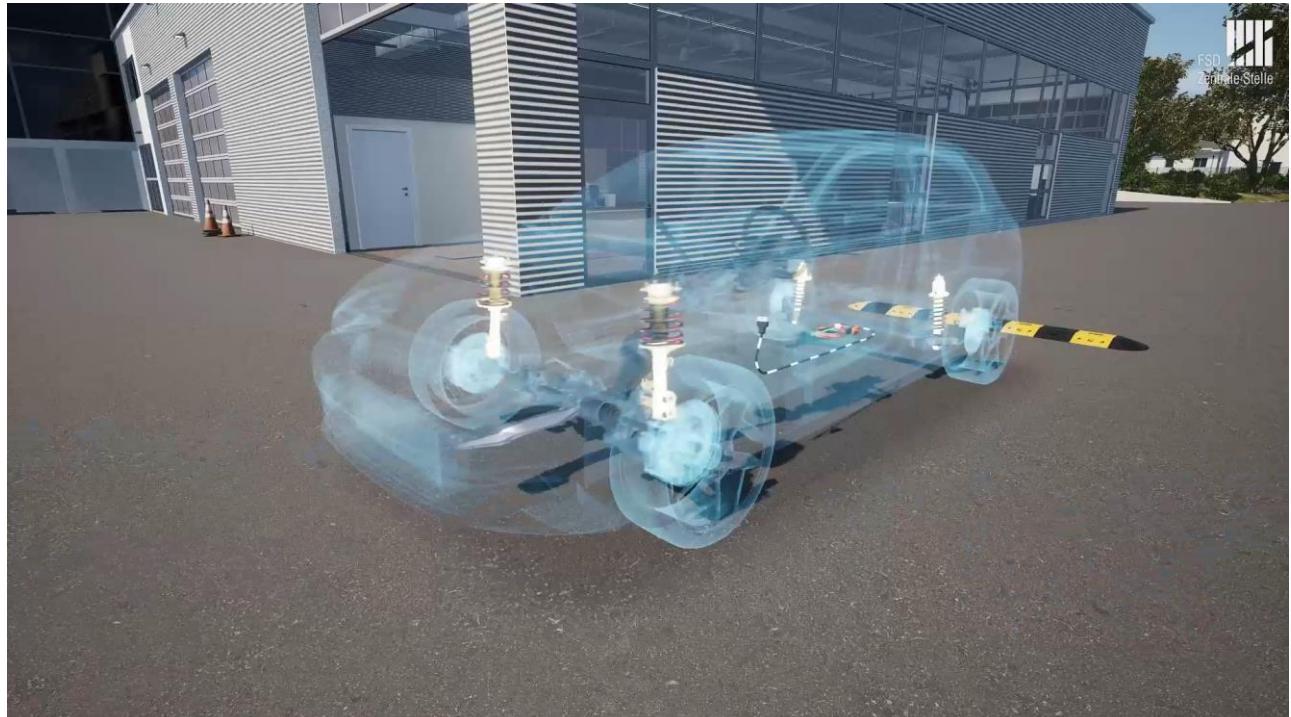
Inspecting the effectiveness – e.g. of the reference braking force test (RBFT)



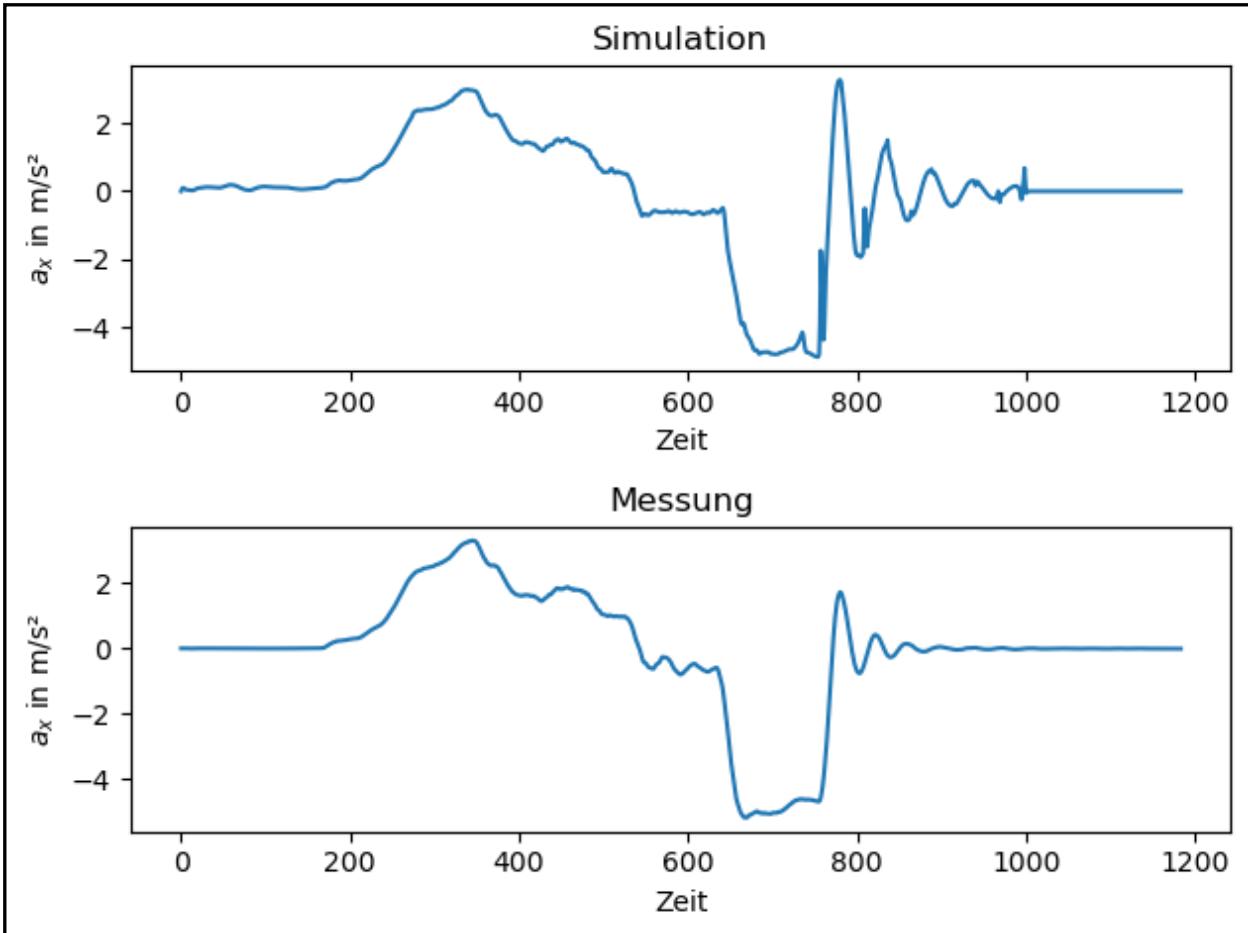
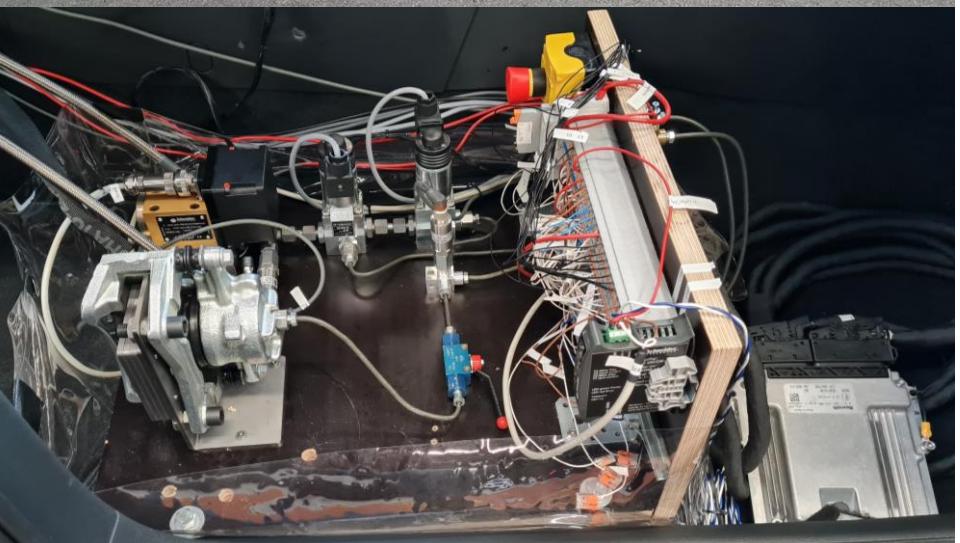
Electronic periodic technical inspection (PTI) Deceleration Measurement

Description of the Measurement Procedure

- Acceleration measurement with HU adapter
- Proof of minimum deceleration during the driving test by measuring longitudinal acceleration
- Evaluation of other vehicle movements using AI (Deep Learning)
- Detection of irregularities in uniformity and brake force distribution



Brake Inspection



Brake Inspection



v0.0.1.26467

Verzögerungsmessung 2.0

BBA FBA

PM

Z_PM

x

=

Z_zGM

zGM_Ber

1840

Diagramm

Verzögerung [m/s²]

Zeit [s]

Status

Nicht geprüft

InspectionState:Idle

STARTEN

The screenshot shows a mobile application interface for brake inspection. At the top, there's a header with icons for battery, signal strength, and a circular button. To the right of the header is the version number "v0.0.1.26467". Below the header, the title "Verzögerungsmessung 2.0" is displayed, followed by "BBA" and "FBA". The main area contains several input fields and a calculation result. On the left, there are fields for "PM" and "Z_PM". In the center, there's a multiplication sign "x" followed by an equals sign "=" and a field for "Z_zGM". Below these fields is a value "1840" and a label "zGM_Ber". A dashed line separates this section from a "Diagramm" (diagram) below. The diagram has a vertical axis labeled "Verzögerung [m/s²]" and a horizontal axis labeled "Zeit [s]". At the bottom of the screen, there's a status box labeled "Status" containing the text "Nicht geprüft" (not inspected). The footer displays the inspection state as "InspectionState:Idle". At the very bottom, there are navigation buttons: a back arrow on the left and a blue "STARTEN" (start) button on the right.

Brake Inspection



v0.0.1.26467

Verzögerungsmessung 2.0

BBA FBA

Optional

Z_PM _____

X _____ = Z_zGM _____

zGM_Ber 1840

✓ Diagramm

Verzögerung [m/s²] Zeit [s]

Status _____

Nicht geprüft

InspectionState:Idle

STARTEN

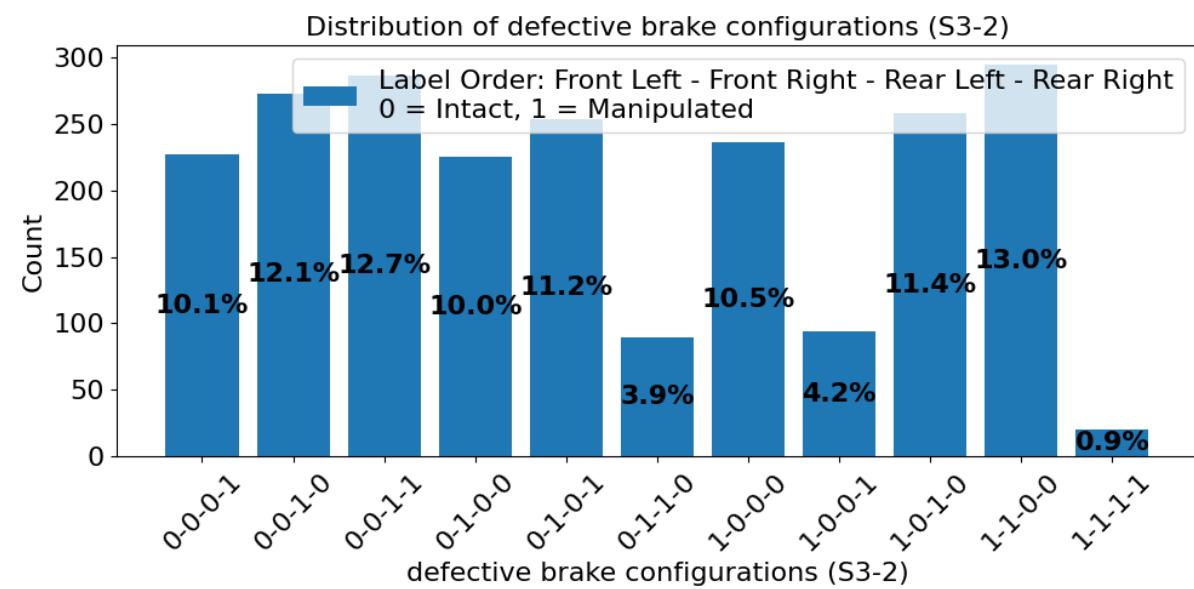
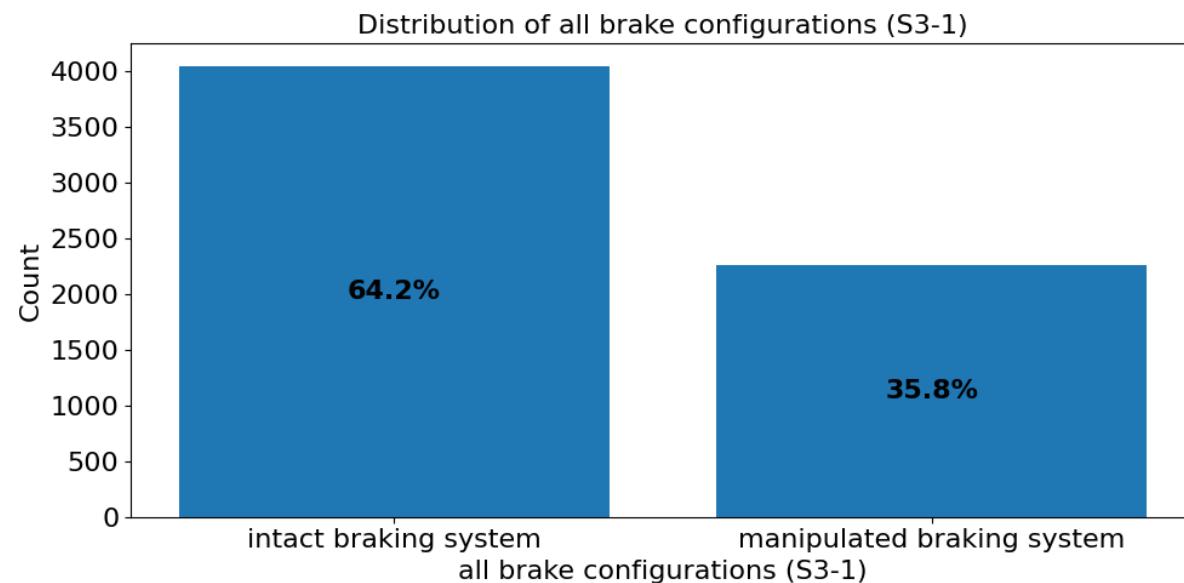
The screenshot shows a mobile application interface for brake inspection. At the top, it displays the version number v0.0.1.26467. The main title is "Verzögerungsmessung 2.0". Below the title, there are two tabs: "BBA" and "FBA", with "BBA" currently selected. Under the "Optional" section, there are input fields for "Z_PM", "X", and "Z_zGM", along with a value "1840" in a box labeled "zGM_Ber". A "Diagramm" section contains a large empty rectangular box for plotting deceleration over time. At the bottom, a status box says "Nicht geprüft" (not checked) and the inspection state is listed as "InspectionState:Idle". A "STARTEN" button is located at the bottom right. The bottom navigation bar includes a back arrow on the left and a start/stop button on the right.

Electronic periodic technical inspection (PTI)

Deceleration Measurement

Dataset overview

- Training vehicles: VW Golf & Passat
- Intact vs. manipulated brake conditions
- Around 6300 measurements total

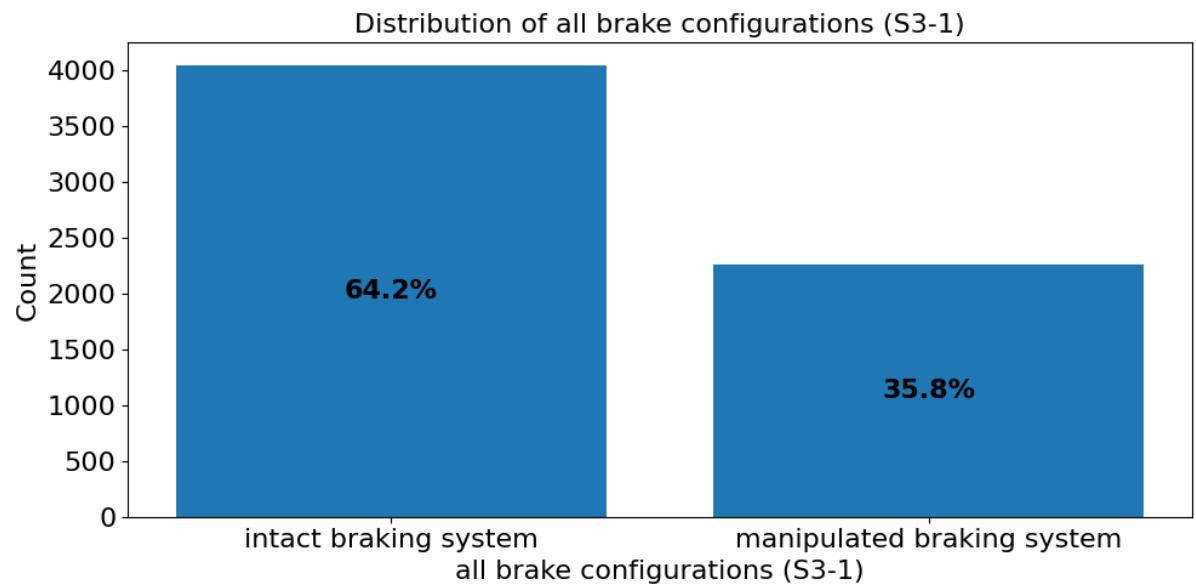


Electronic periodic technical inspection (PTI)

Deceleration Measurement

Challenges in degraded brake data

- Need for even more data

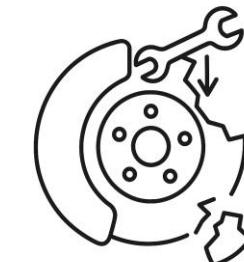
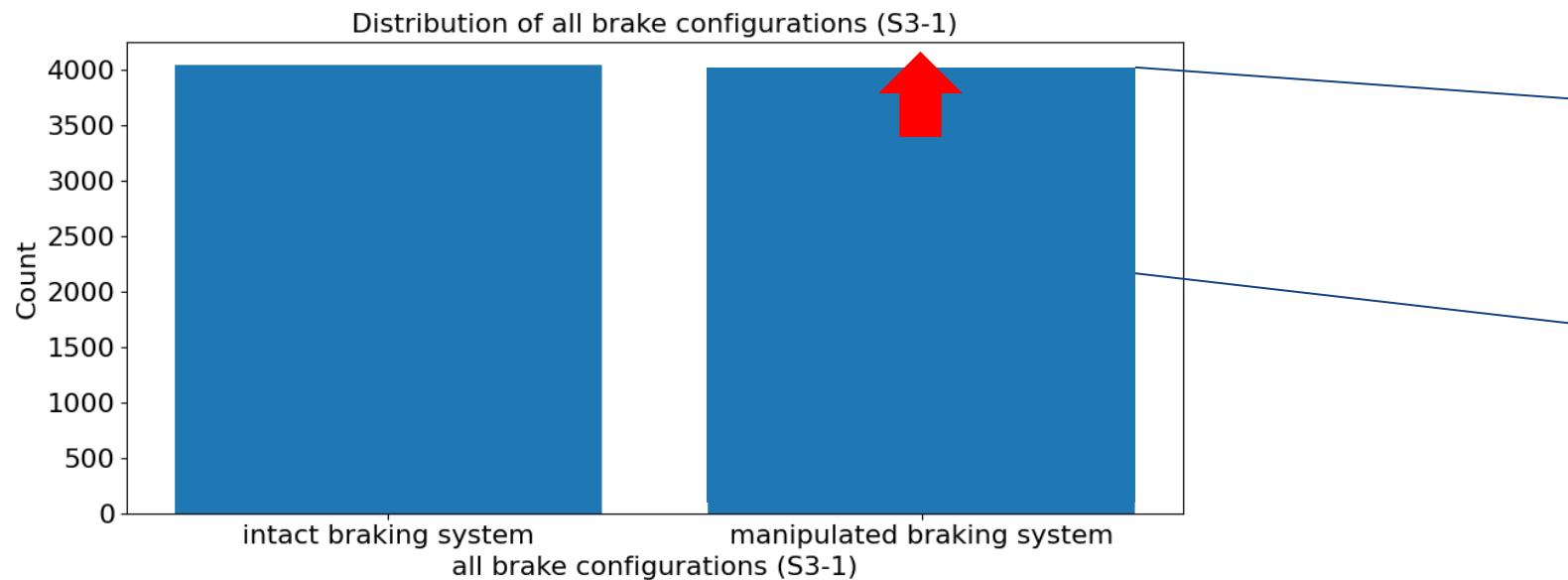


Electronic periodic technical inspection (PTI)

Deceleration Measurement

Challenges in degraded brake data

- Need for even more data
- Especially more varied and controlled degraded cases

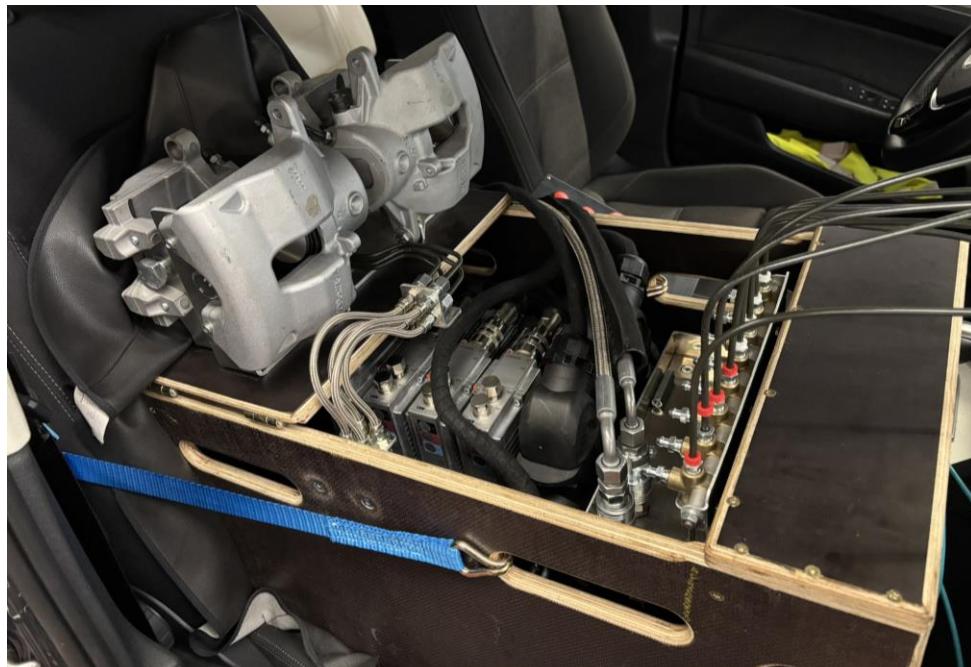


Electronic periodic technical inspection (PTI)

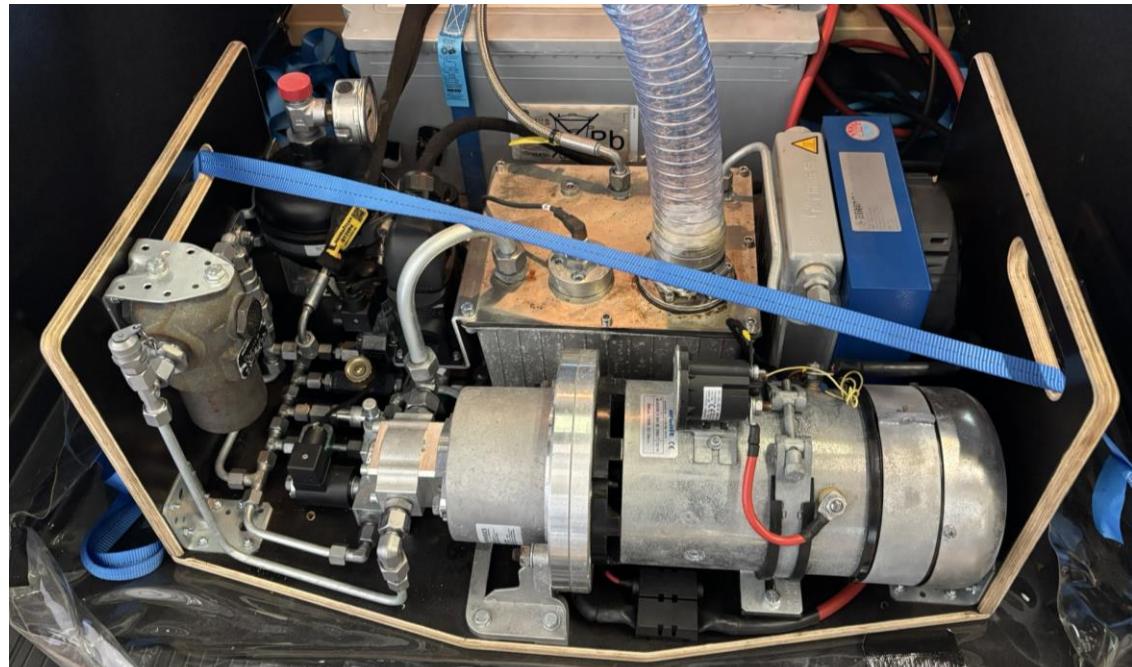
Deceleration Measurement

Brake Pressure Manipulator (BPM)

- System for wheel-specific brake pressure control
- Allows precise degradation of brake force
- Integrated into real vehicles (e.g., VW Passat)



Control unit on passenger seat



Pressure supply in boot

Electronic periodic technical inspection (PTI)

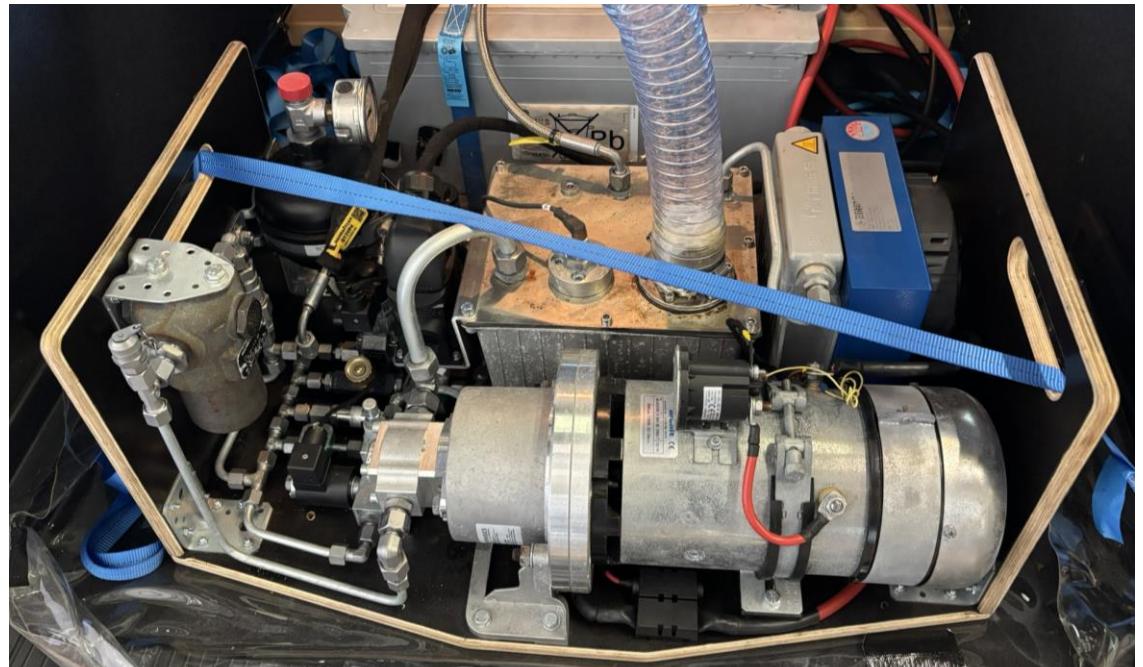
Deceleration Measurement

Brake Pressure Manipulator (BPM)

- Enables systematic and safe data collection for Deep Learning Training
- Creates realistic, labeled braking anomalies
- Increases dataset diversity and classifier robustness



Control unit on passenger seat



Pressure supply in boot



3 | Project Tasks

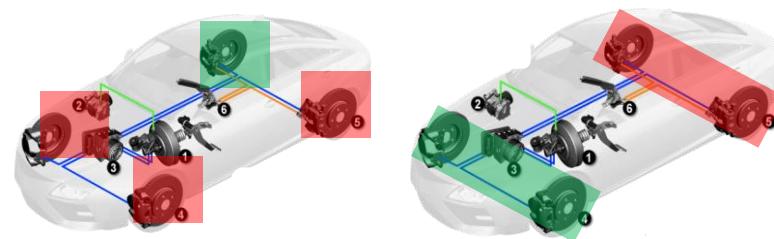
Project Task

Task description:

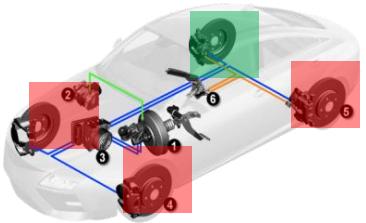
Classification of brakes as intact or defective using measurement series of linear acceleration and angular velocities in the x, y, z directions.

The data:

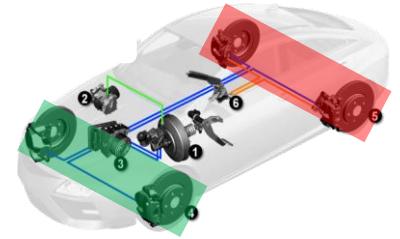
- 2 data files: Train.pkl & Test.pkl
- Both contain:
 - Braking events with various configurations
 - Recording of linear accelerations (a_x , a_y , a_z) and angular rates (r_x , r_y , r_z)
 - Braking events from approximately 20 km/h
 - Meta information



Project Tasks

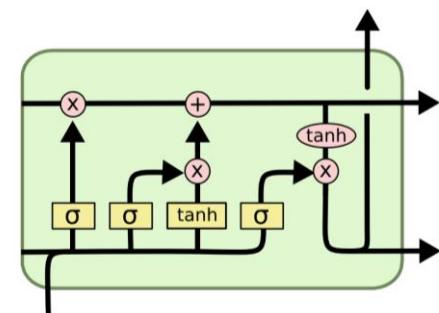
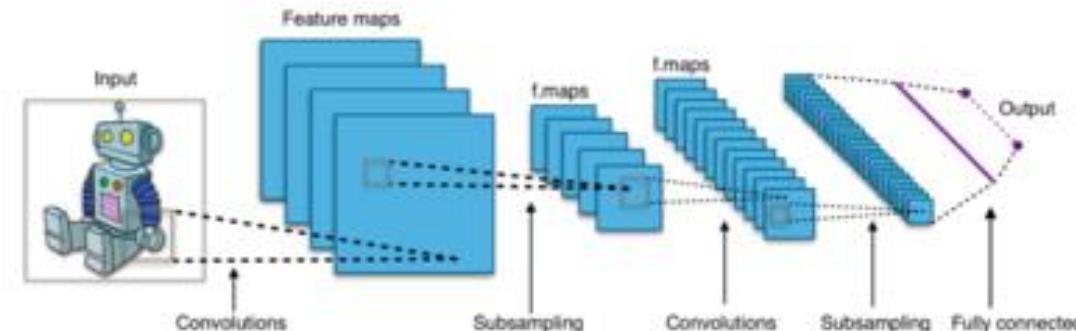
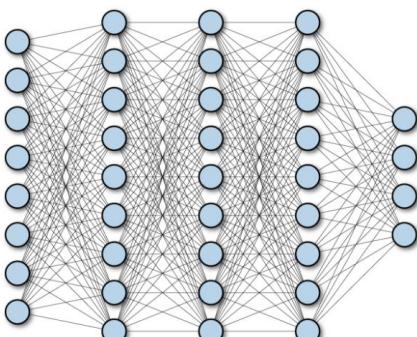


Classification of brakes as conspicuous or inconspicuous



Fully connected Networks (FCN), Convolutional Neural Networks (CNNs) and Long Short-Term Memory Networks (LSTMs)

Implementation of a FCN, 2D-CNN and an LSTM, including parameter tuning Comparison of the two networks



Project Tasks

Classification of brakes as conspicuous or inconspicuous
Classification of brakes as intact or defective using measurement series of linear acceleration and angular velocities in the x, y, z directions.

Topic 1

Generative AI

Topic 2

Preprocessing, Data Augmentation & Variational Autoencoder

Group Gemini
Oleksander
Linus
Anupama
Sara

Group Lasagne
Tim
Moritz
Helmi
Malak

Group ZLXM
Xuliang
Jingyao
Chenwei
Moritz

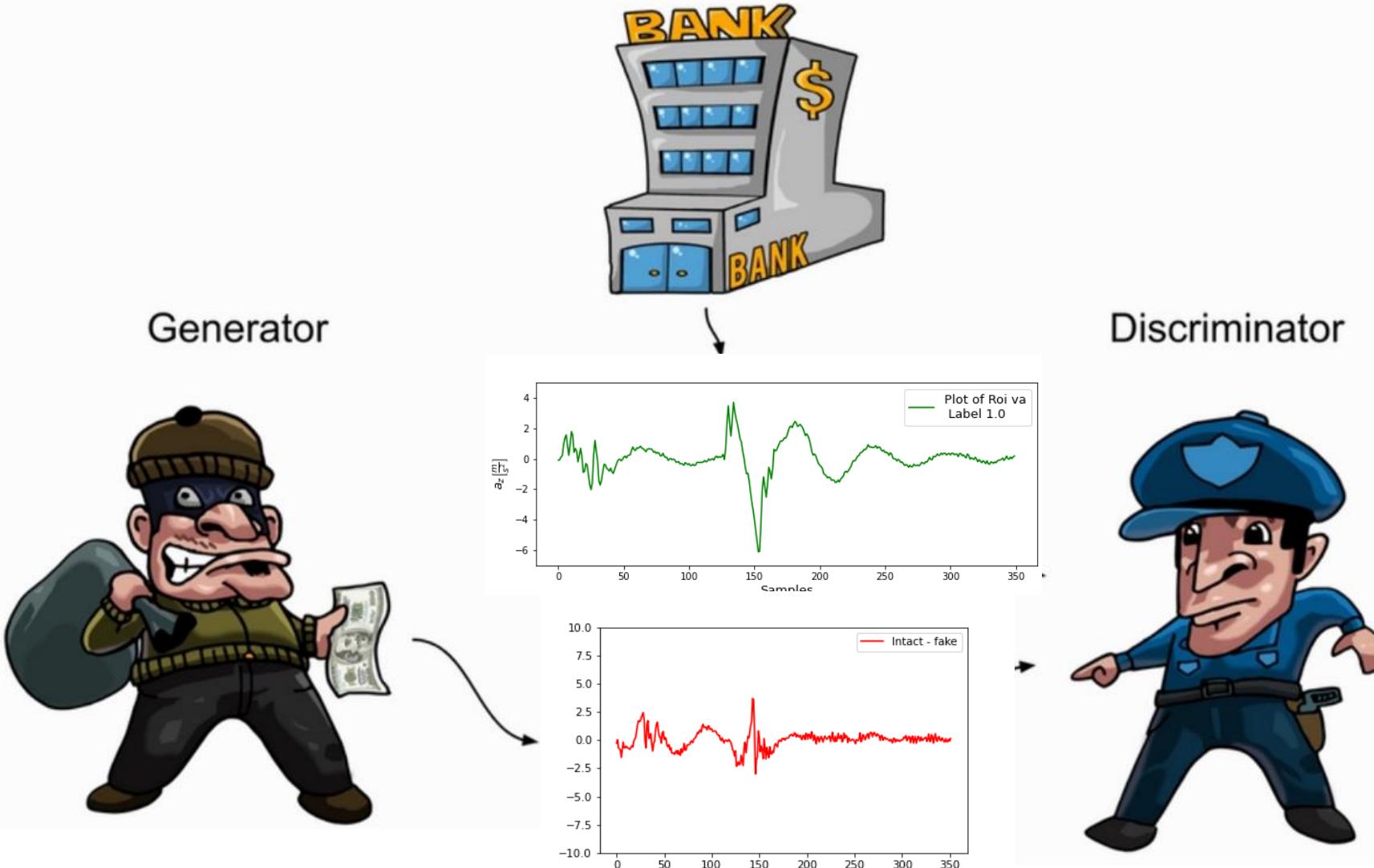
Group HalloLeute
Daniel
Nikita
Chaeran
Sebastian

Group Beam
Ben
Erik
Anna
Martin

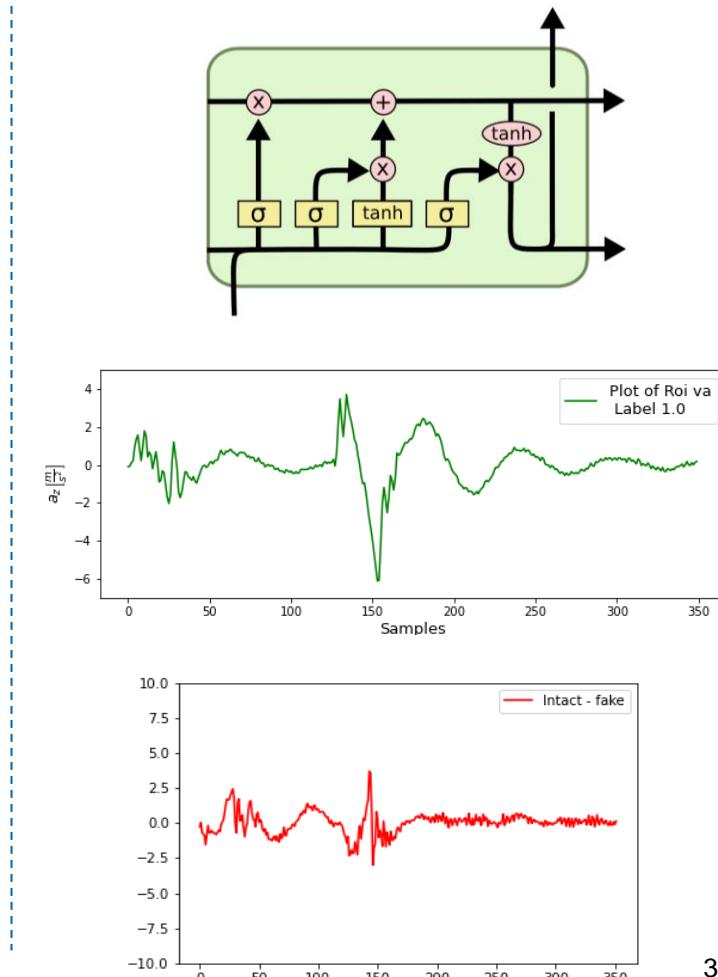
Project Tasks

Topic 1

Signal generation with GANs



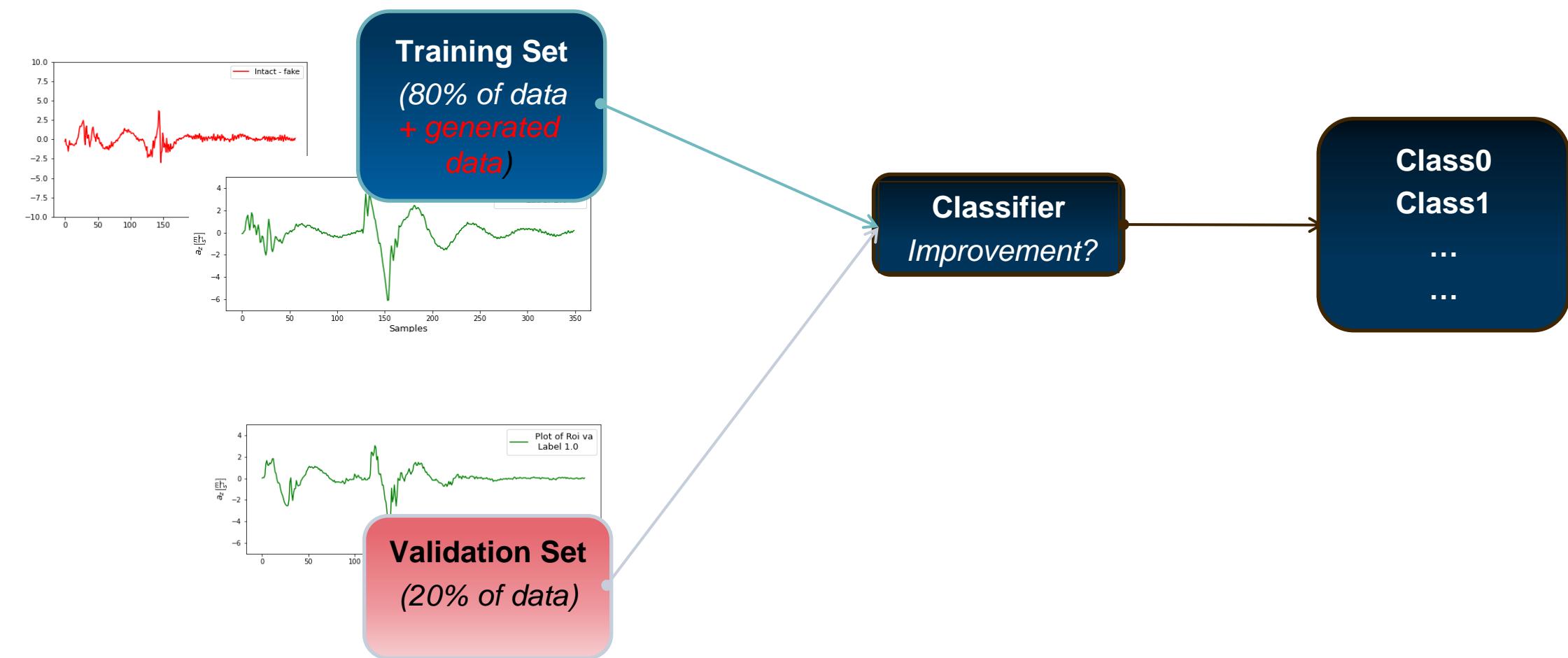
vs. RNNs



Project Tasks

Topic 1

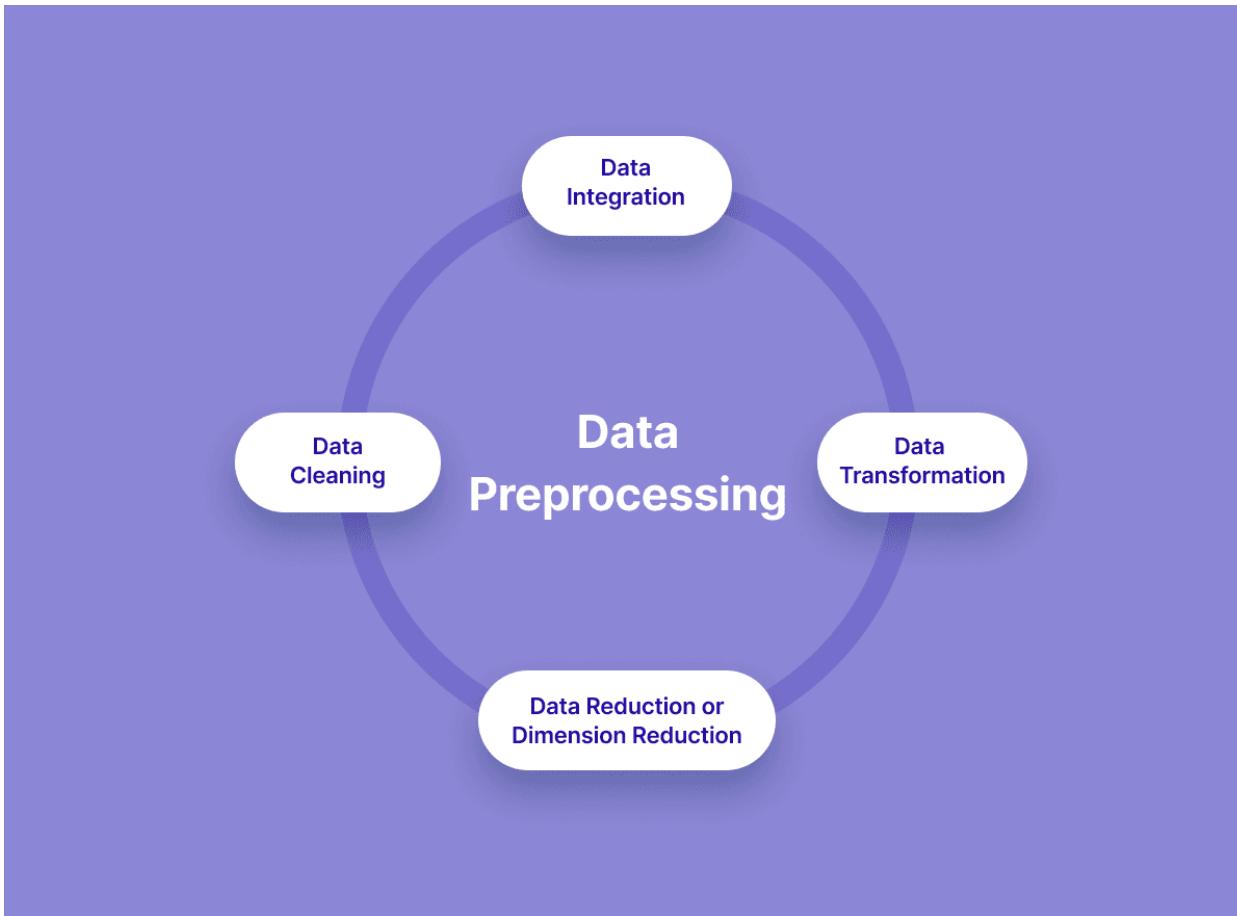
- Add generative Data



Project Tasks

Topic 2

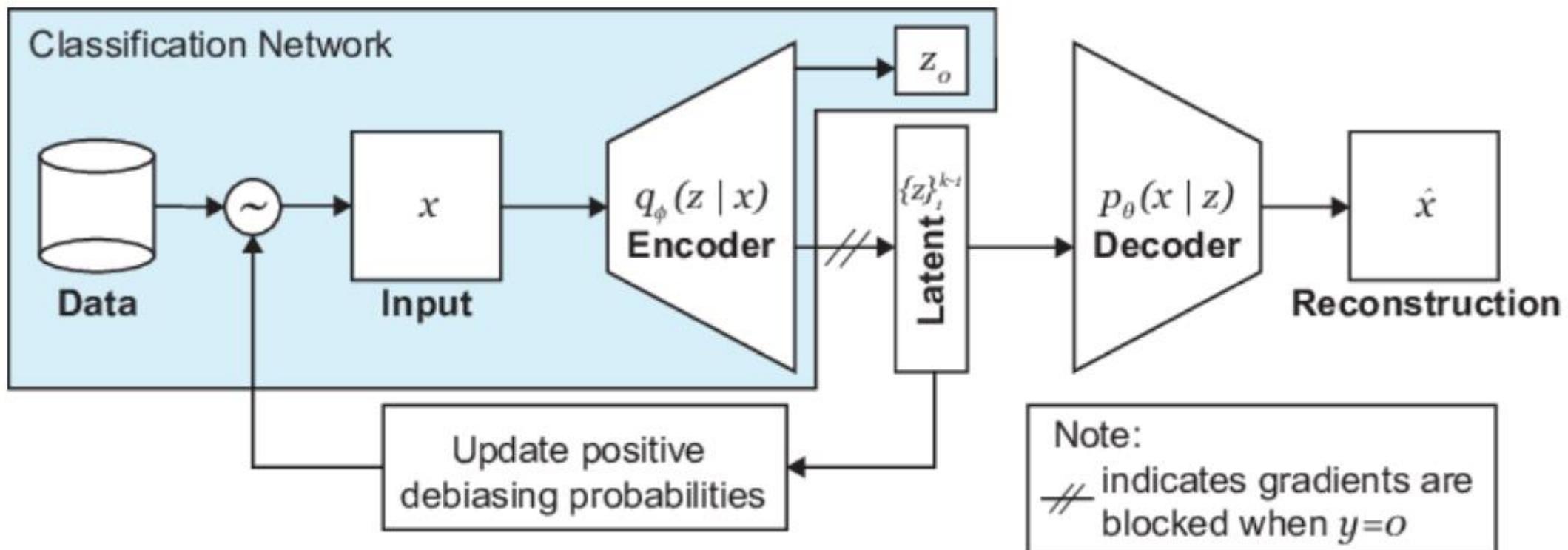
- Data Preprocessing



Project Tasks

Topic 2

- Debiasing Autoencoder



Debiasing Variational Autoencoder. Architecture of the semi-supervised DB-VAE for binary classification (blue region). The unsupervised latent variables are used to adaptively resample the dataset while training.

Project Tasks

Topic 2

■ Data Augmentation

Data Augmentation

Color

Color



Example of maximum color shift

Affine

OFF Horizontal flip

OFF Vertical flip

Rotate

Max. rotation 30



Example of maximum distortion

Crop

Crop

Min. kept ratio 0,75



Example of maximum crop

Original image [CHANGE IMAGE](#)



Augmentation examples



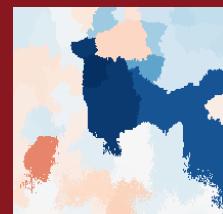
Project Tasks

Additional Tasks

Additional Tasks (for every one)

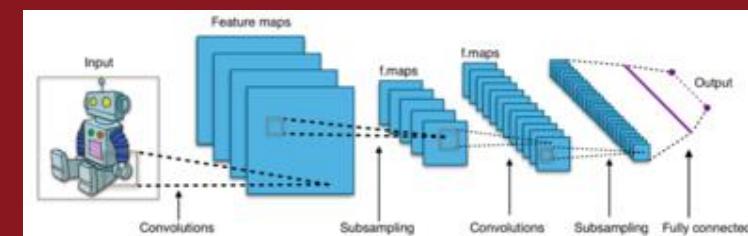
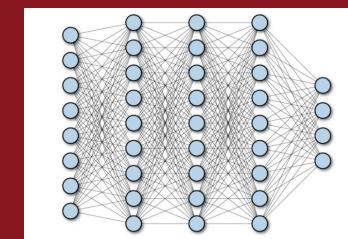
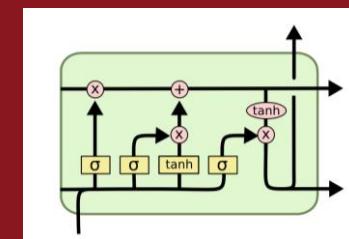
Explainable AI (XAI)

Study on the visual interpretability of neural network results
to enhance trust in the technology



Ensemble Classifier

Improve Classifier performance & generalization

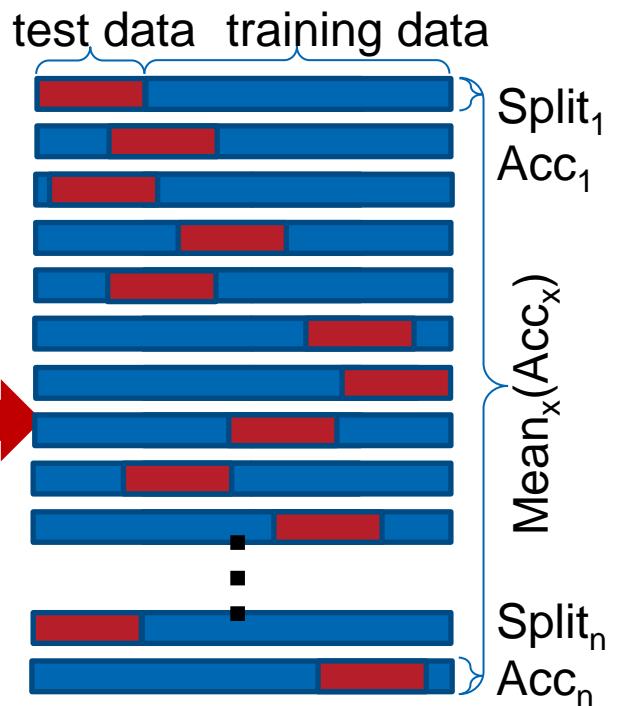


Vote

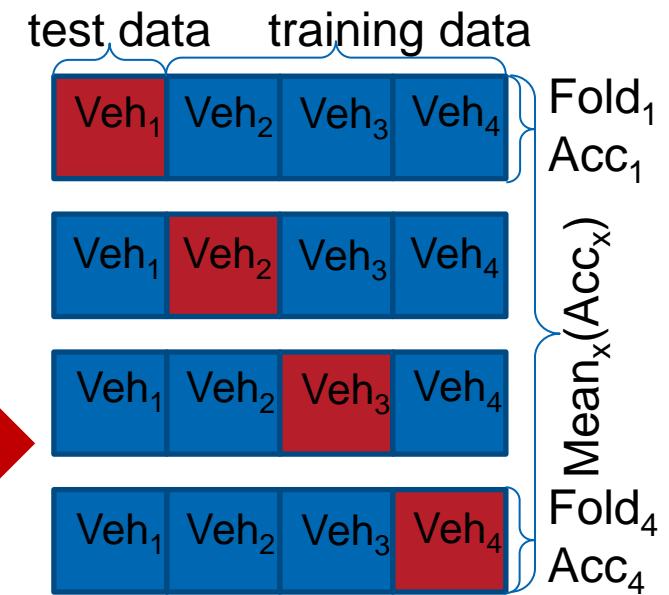
Validation Methods

Random Split vs. LOGO

random split



LOGO



Open positions

- <https://fsd-web.de/karriere/#wissenschaftlichearbeiten>
- Working student / Diploma Thesis ESP Inspection Technology
- Working student Data Analysis ADAS