Session III
Testbed Dresden – Synchronized Mobility 2023

4th ASAM International Conference 2019

Autonomous Driving – Standardized Virtual Development as a Key to Future Mobility

hosted in cooperation with the Saxon State Ministry for Economic Affairs, Labour and Transport

December 10th, 2019 in Dresden, Germany

saena
Sächsische Energieagentur GmbH

SYNCHRONE MOBILITÄT 2023

Agenda

15:30 – 15:50	„Synchrone Mobilität 2023“ – An Initiative of the Free State of Saxony
15:50 – 17:00	Automated Driving System for Cooperative, Automated Driving in Urban Areas
	HMI in the Vehicle
	ITS Testbed Backend for Automated Urban Traffic
	Roadside Infrastructure for Connected Driving
	Simulation based research of automated longitudinal control with GLOSA functionality
	Traffic and Accident Scenarios Merged in the Harmonized PCM v5 Standard

saena Sächsische Energieagentur GmbH

SYNCHRONE MOBILITÄT 2023

Testbed Dresden – Synchronized Mobility 2023

Traffic and accident scenarios merged in the harmonized PCM v5 standard

Florian Spitzhüttl, VUFO GmbH

Martin Urban, Fraunhofer Institute for Transportation and Infrastructure Systems

VUFO GmbH

Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

Testbed Dresden – Synchronized Mobility 2023

Real scenario (accidents & critical events)

Different investigation methods and databases

SePIA PRÜF- UND TESTSZENARIEN

Europa fördert Sachsen. EFRE

EUSKA

POLIZEI Sachsen

POLIZEI Brandenburg

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

VUFO GmbH

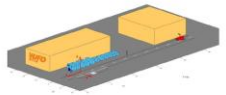
NDS

FSD Zentrale Stelle

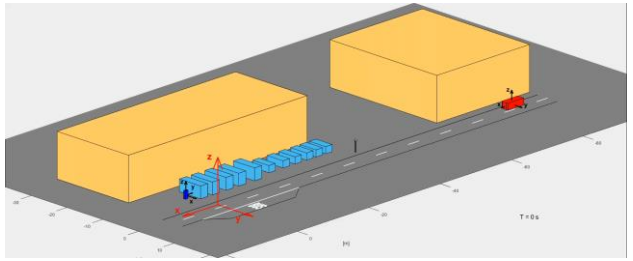
NDS

Digitalized scenario

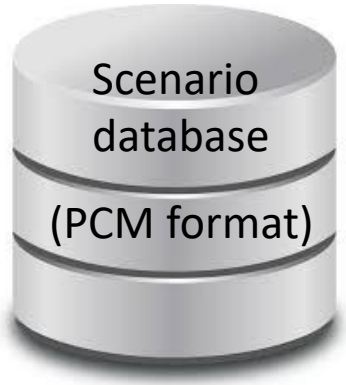
PCM format specification



Open access @vufo.de



Merged database for analyses and simulation



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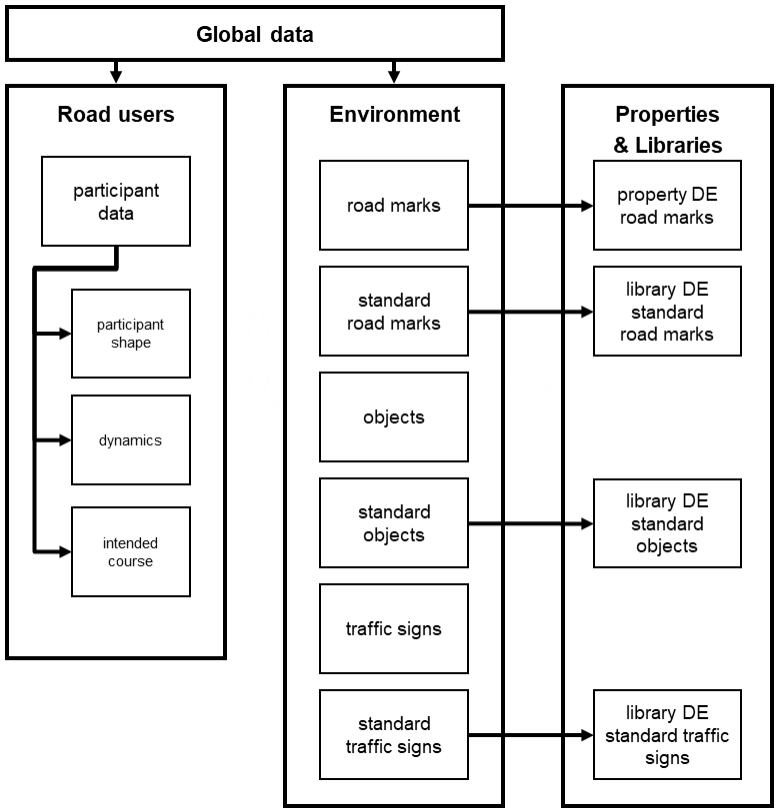
Fraunhofer IVI

Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

Pre-Crash-Matrix (PCM) format



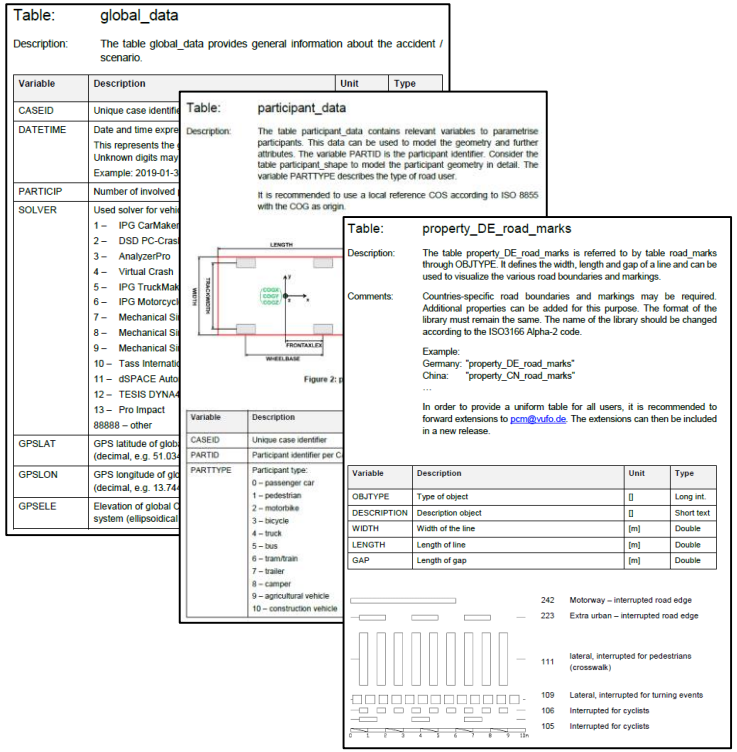


Table: global_data

Description: The table global_data provides general information about the accident / scenario.

Variable	Description	Unit	Type
CASEID	Unique case identifi		
DATETIME	Date and time expre This represents the Unknown digits may Example: 2019-01-3		
PARTICIP	Number of involved		
SOLVER	Used solver for vehi 1 – IPG CarMaker 2 – DSD PC-Cras 3 – AnalyzerPro 4 – Virtual Crash 5 – IPG TruckMak 6 – IPG Motorcycl 7 – Mechanical Si 8 – Mechanical Si 9 – Mechanical Si 10 – Tass Internatio 11 – dSPACE Auto 12 – TESIS DYNA4 13 – Pro Impact 88888 – other		
GPSLAT	GPS latitude of glob (decimal, e.g. 51.034		
GPSLON	GPS longitude of glo (decimal, e.g. 13.74		
GPSELE	Elevation of global C system (ellipsoidical		

Table: participant_data

Description: The table participant_data contains relevant variables to parametrise participants. This data can be used to model the geometry and further attributes. The variable PARTID is the participant identifier. Consider the table participant_shape to model the participant geometry in detail. The variable PARTTYPE describes the type of road user.

It is recommended to use a local reference COS according to ISO 8855 with the COG as origin.

Variable	Description
CASEID	Unique case identifier
PARTID	Participant identifier per C
PARTTYPE	Participant type: 0 – passenger car 1 – pedestrian 2 – motorbike 3 – bicycle 4 – truck 5 – bus 6 – tram/train 7 – trailer 8 – camper 9 – agricultural vehicle 10 – construction vehicle

Table: property_DE_road_marks

Description: The table property_DE_road_marks is referred to by table road_marks through OBJTYPE. It defines the width, length and gap of a line and can be used to visualize the various road boundaries and markings.

Comments: Countries-specific road boundaries and markings may be required. Additional properties can be added for this purpose. The format of the library must remain the same. The name of the library should be changed according to the ISO3166 Alpha-2 code.

Example:
Germany: "property_DE_road_marks"
China: "property_CN_road_marks"
...

In order to provide a uniform table for all users, it is recommended to forward extensions to pcm@vufo.de. The extensions can then be included in a new release.

Variable	Description	Unit	Type
OBJTYPE	Type of object	[]	Long int.
DESCRIPTION	Description object	[]	Short text
WIDTH	Width of the line	[m]	Double
LENGTH	Length of line	[m]	Double
GAP	Length of gap	[m]	Double

242 Motorway – interrupted road edge
223 Extra urban – interrupted road edge
111 lateral, interrupted for pedestrians (crosswalk)
109 Lateral, interrupted for turning events
106 Interrupted for cyclists
105 Interrupted for cyclists

Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

Accident data in PCM

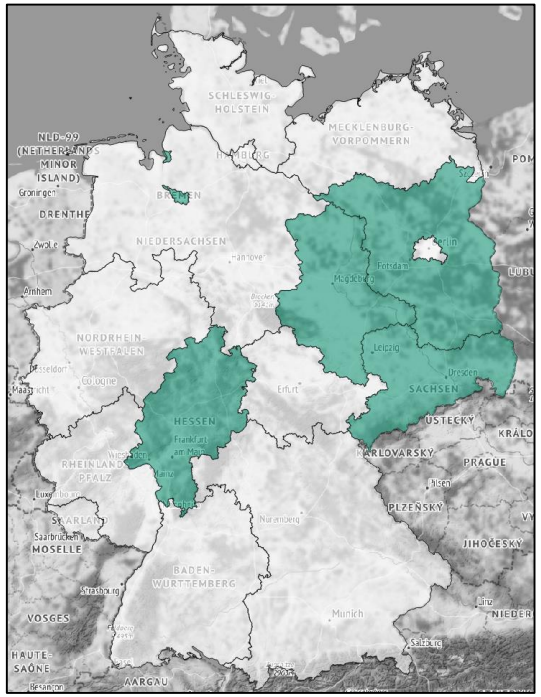
German In-Depth Accident Study[1]

[1] provide by VUFO GmbH

- 36.000 accidents since 1999
- Ø 3.500 single information per accident
- ~ 2.000 accidents per year

Traffic Accident Scenario Community[2]

[2] provide by Fraunhofer IVI



POLIZEI Sachsen
POLIZEI Brandenburg
POLIZEI Sachsen-Anhalt
POLIZEI Hamburg
Polizei Hessen
Polizei Bremen

- ~ 4,1 Mio. accidents since 2010
- Ø 110 single information per accident
- ~ 500.000 accidents per year

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Fraunhofer IVI

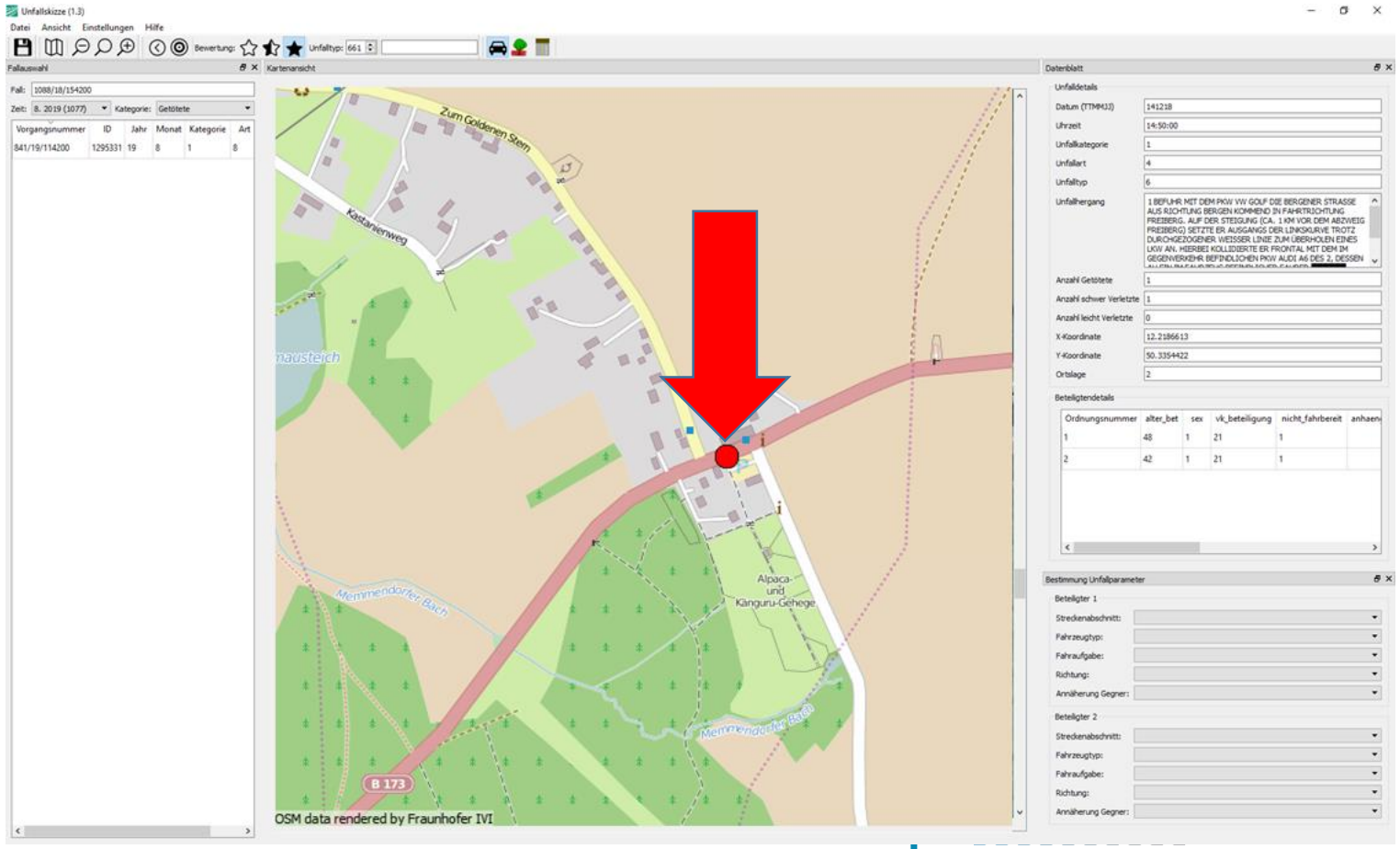
Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

content EUSka database

- Location



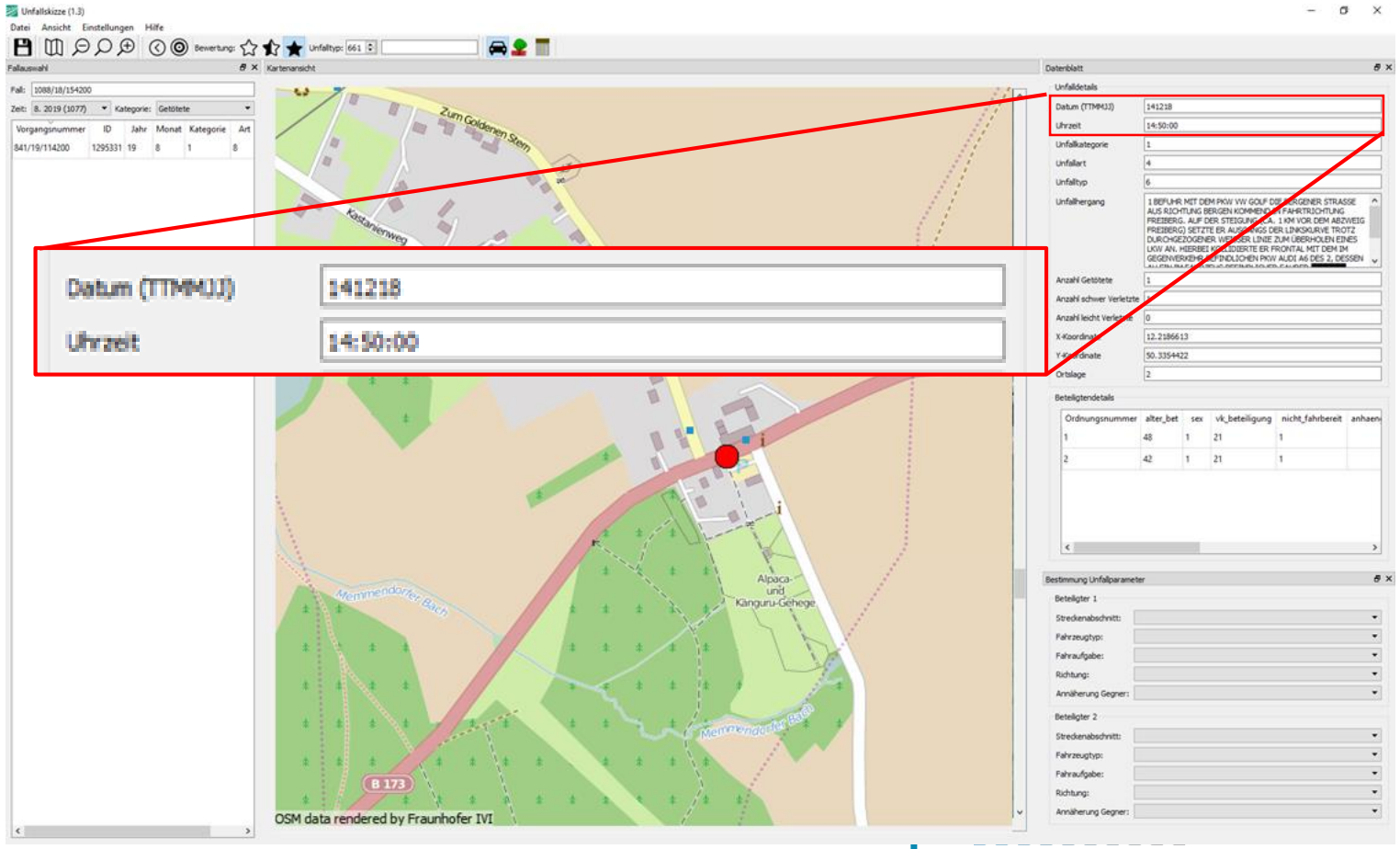
Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

content EUSka database

- Location
- Date and time



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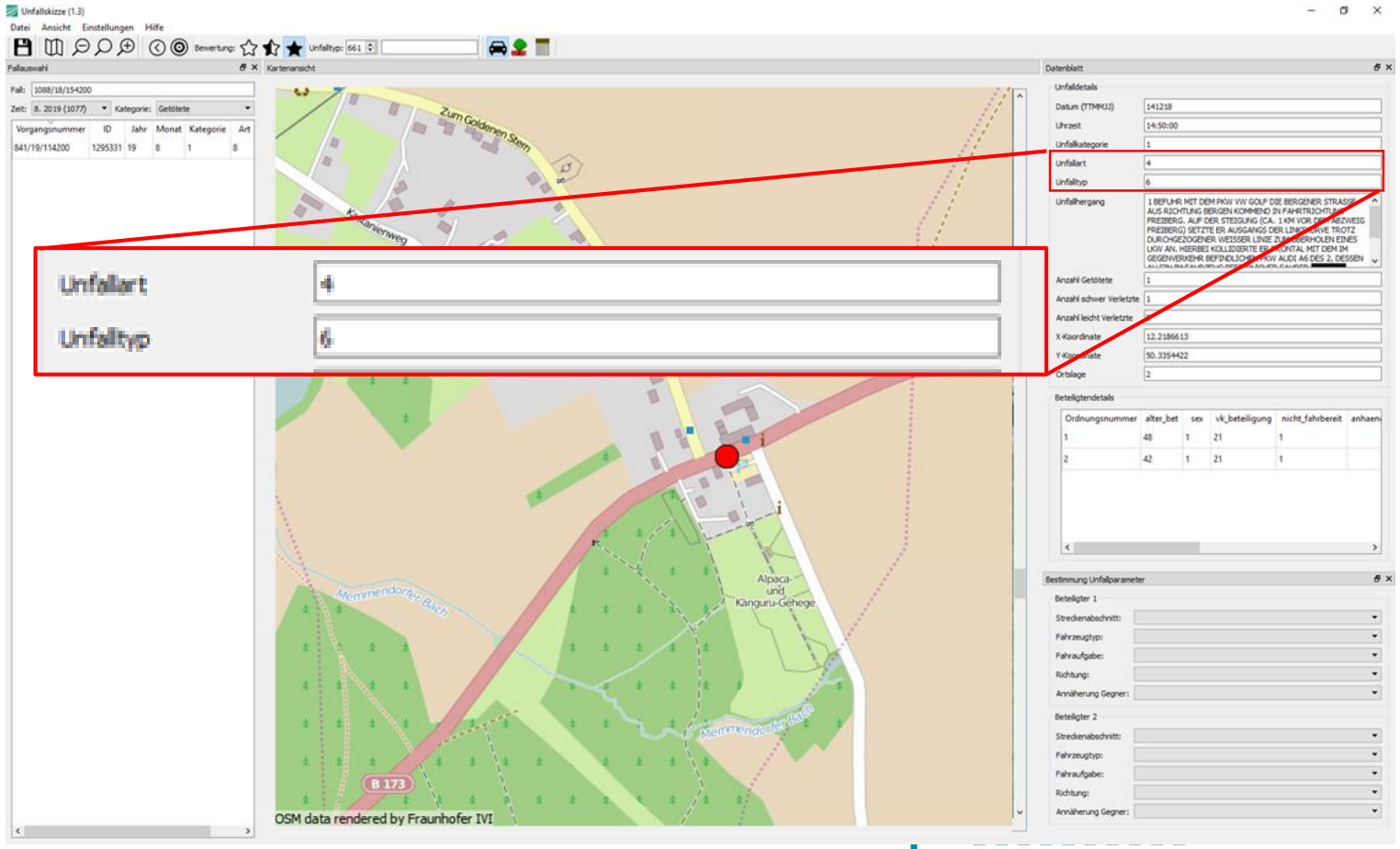
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident



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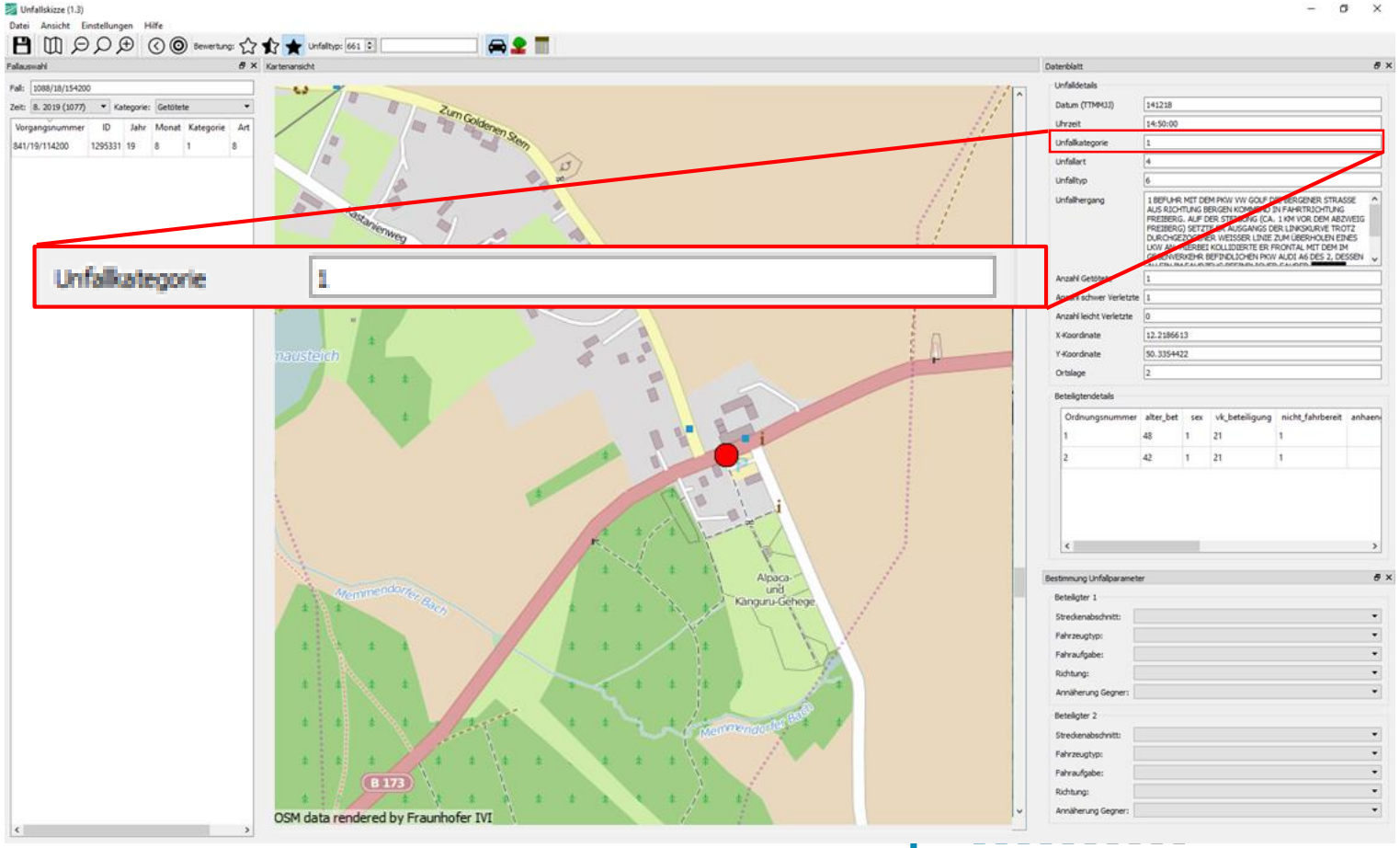
Martin Urban – Fraunhofer IVI

from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident
- Accident category (severity)



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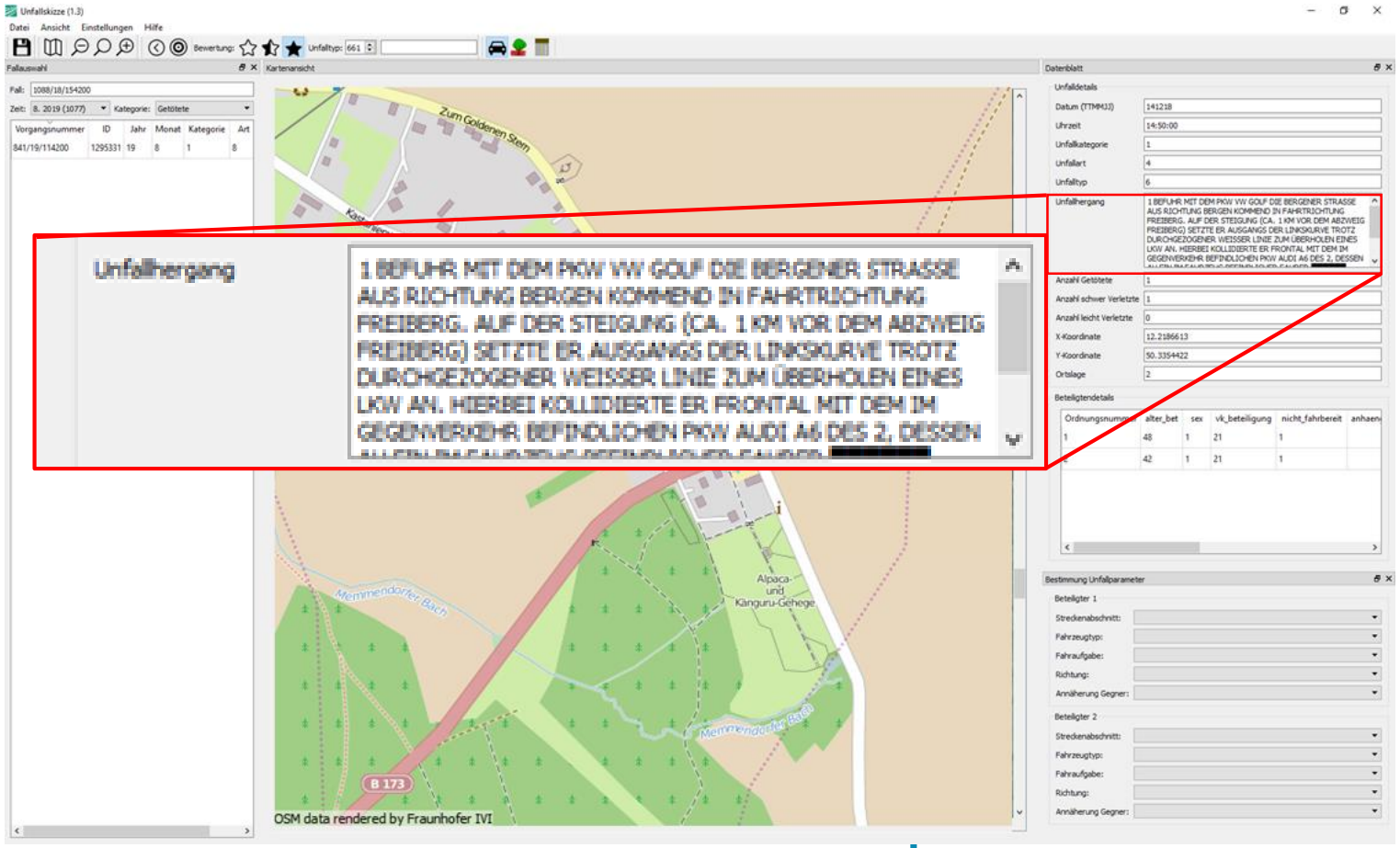
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident
- Accident category (severity)
- Description



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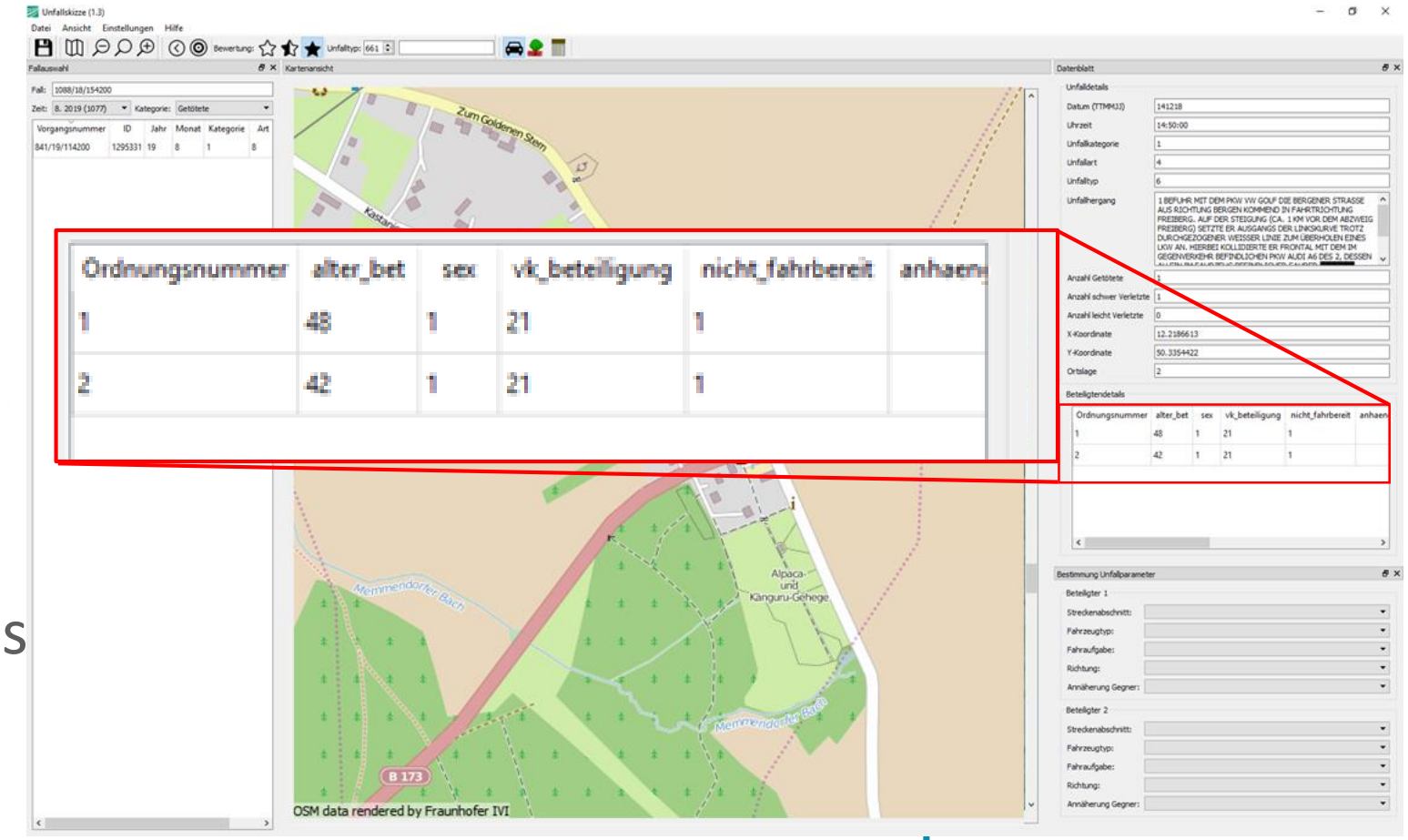
Martin Urban – Fraunhofer IVI

from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident
- Accident category (severity)
- Description
- Kind and type of participants



Ordnungsnummer	alter_bet	sex	vk_beteiligung	nicht_fahrbereit	anhaen
1	48	1	21	1	
2	42	1	21	1	

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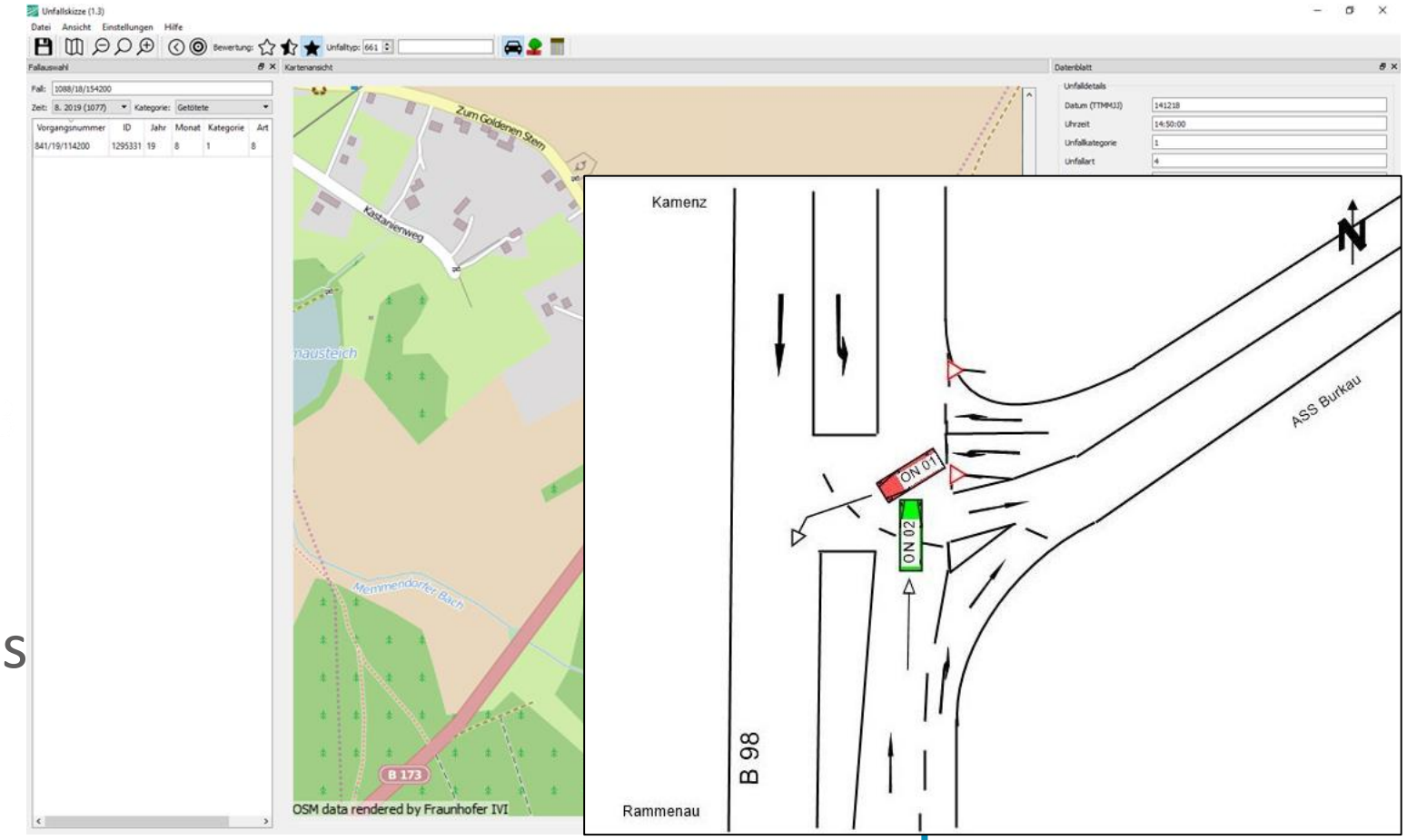
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

content EUSka database

- Location
- Date and time
- Kind and type of accident
- Accident category (severity)
- Description
- Kind and type of participants
- Accident sketch



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Martin Urban – Fraunhofer IVI

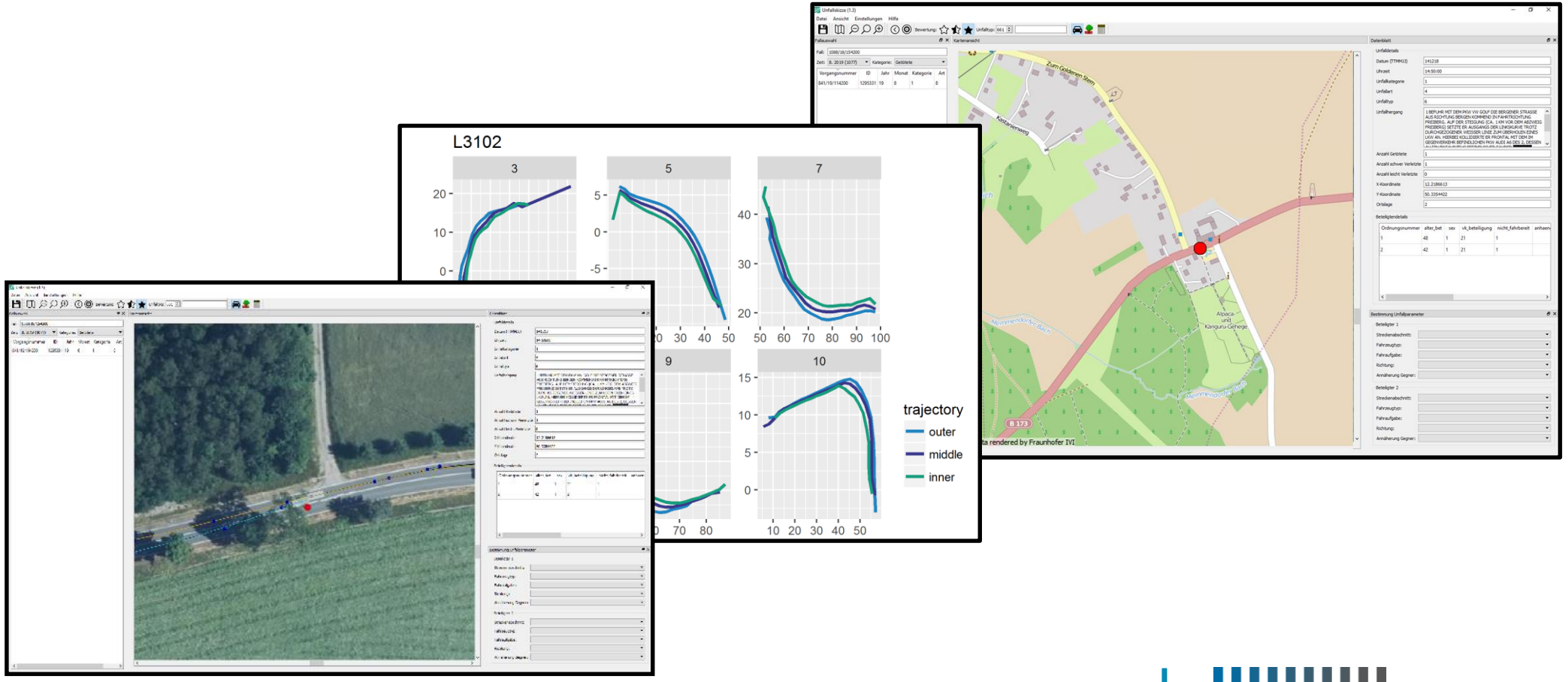
SYNCHRONE MOBILITÄT 2023

Testbed Dresden – Synchronized Mobility 2023

from police recorded accidents to simulation

input

- Police recorded accidents
- Speed values and behaviour (AIMATS)
- Aero Images and Maps



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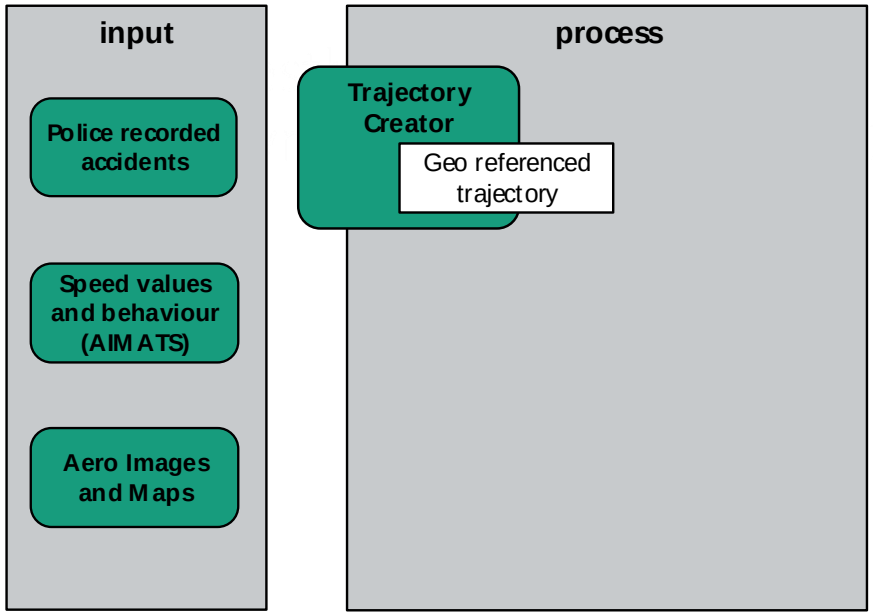
Martin Urban – Fraunhofer IVI

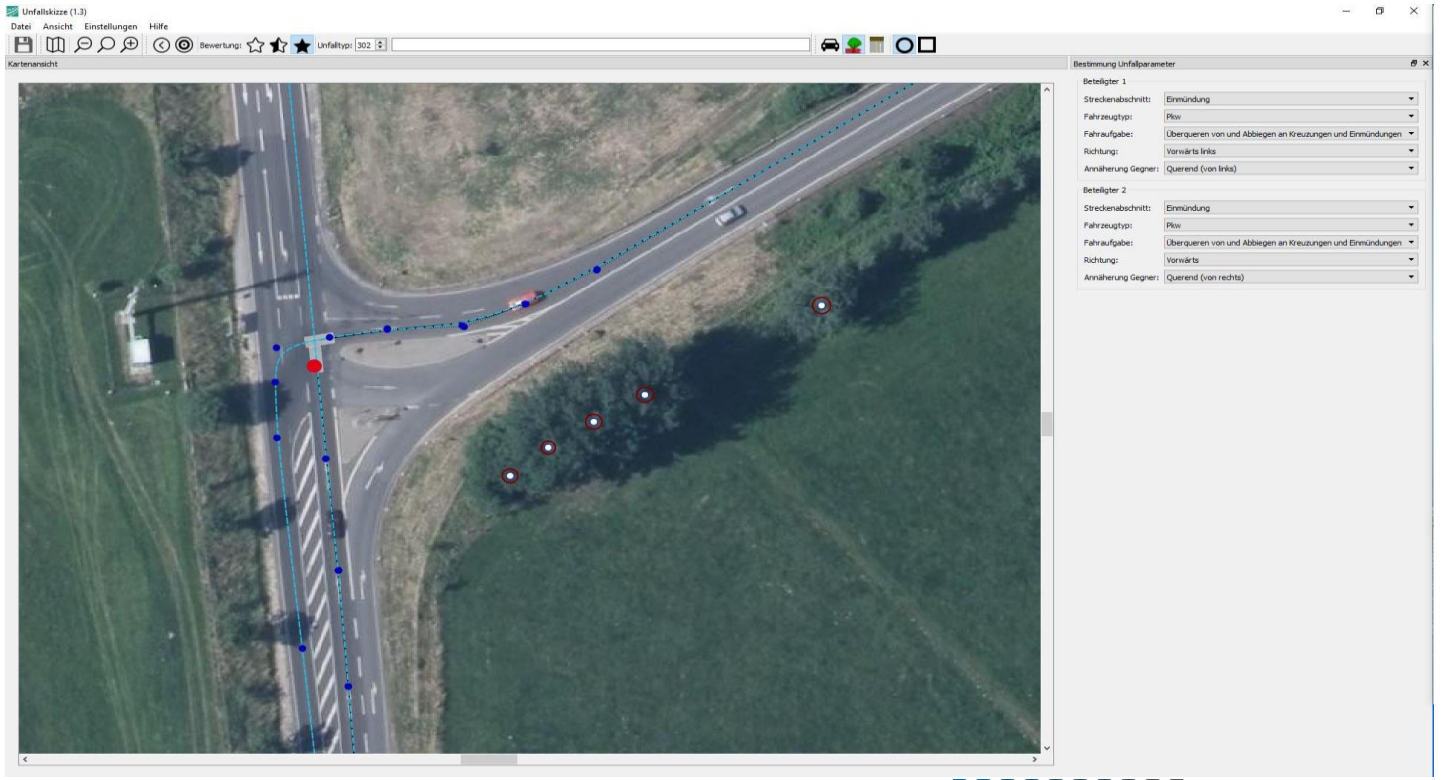
SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

Information added by Fraunhofer

- Trajectory of each participant





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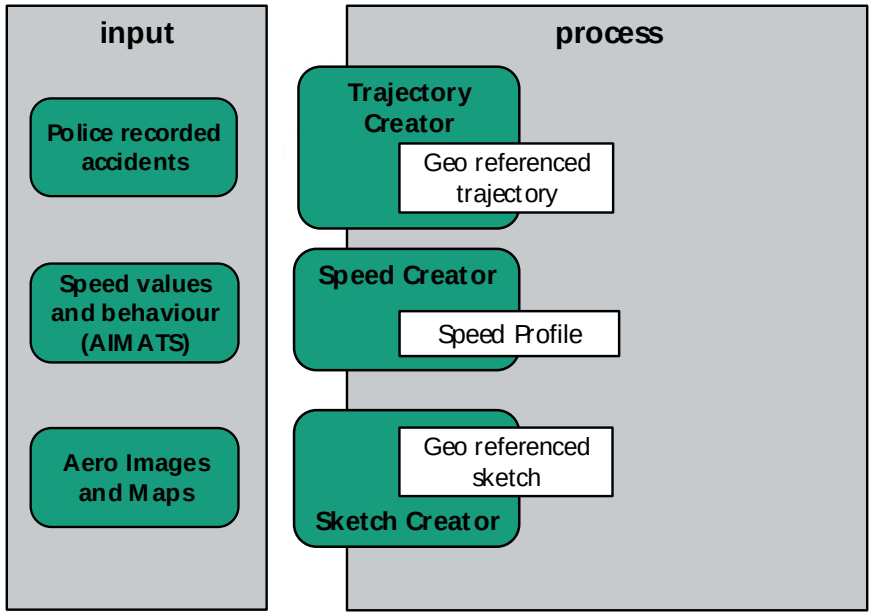
SYNCHRONE MOBILITÄT 2023

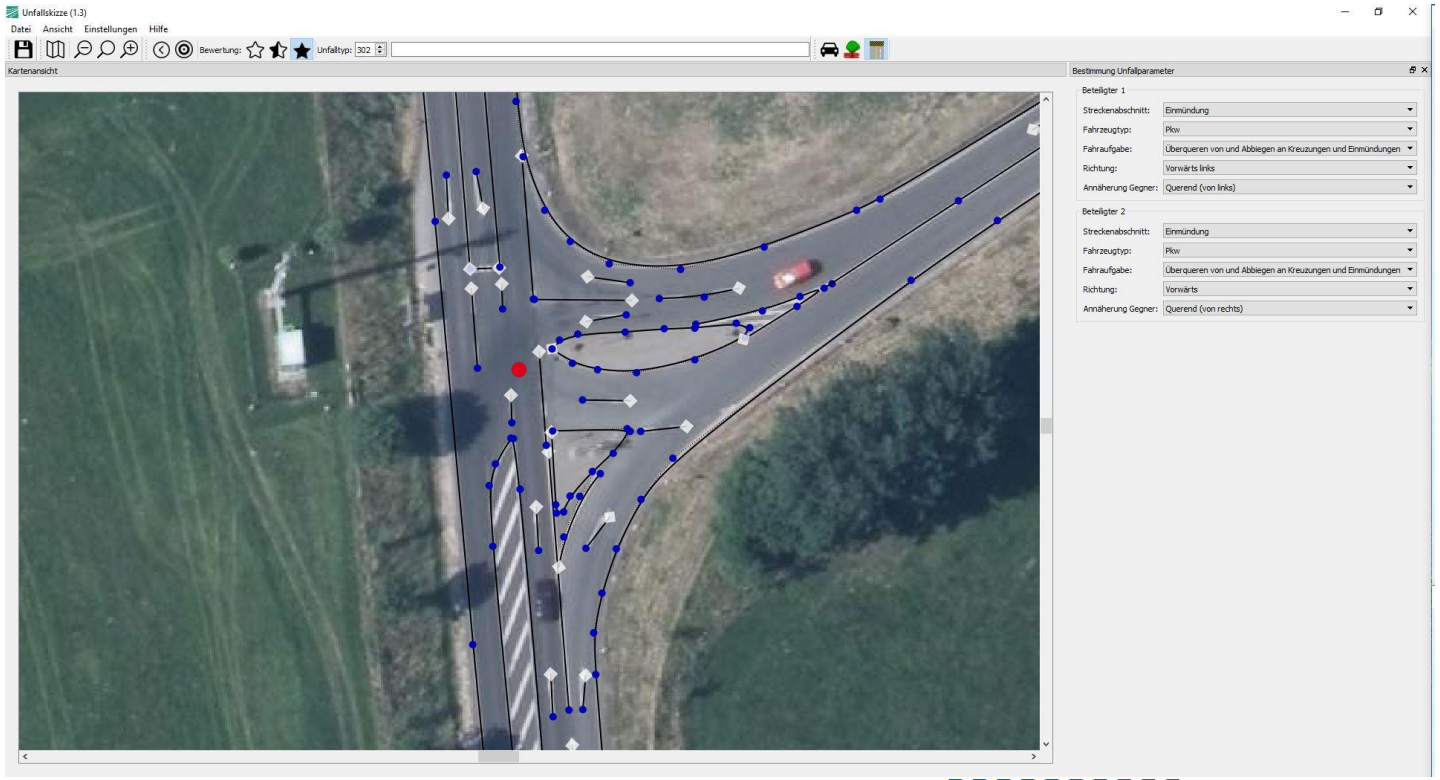
Testbed Dresden – Synchronized Mobility 2023

from police recorded accidents to simulation

Information added by Fraunhofer

- Roadside, lanes and marks





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Fraunhofer IVI

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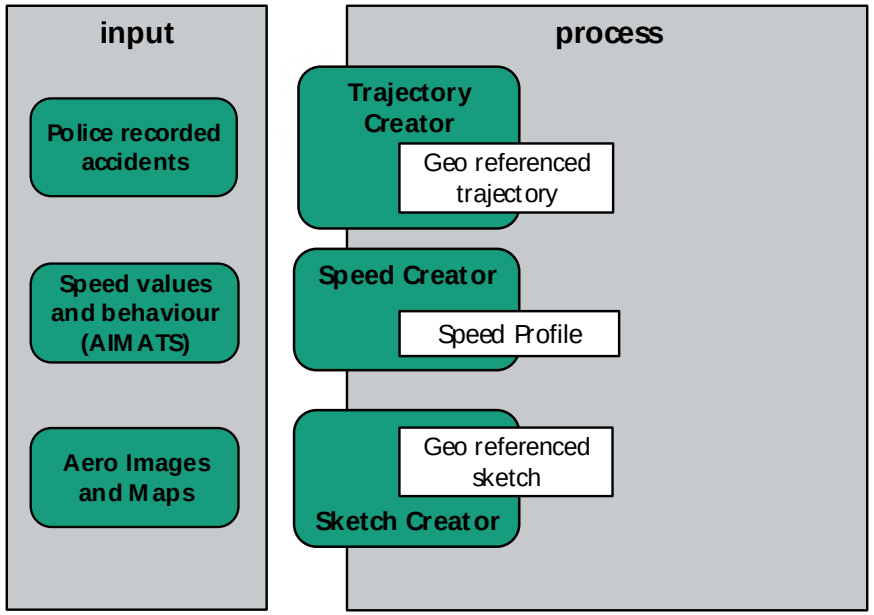
Martin Urban – Fraunhofer IVI

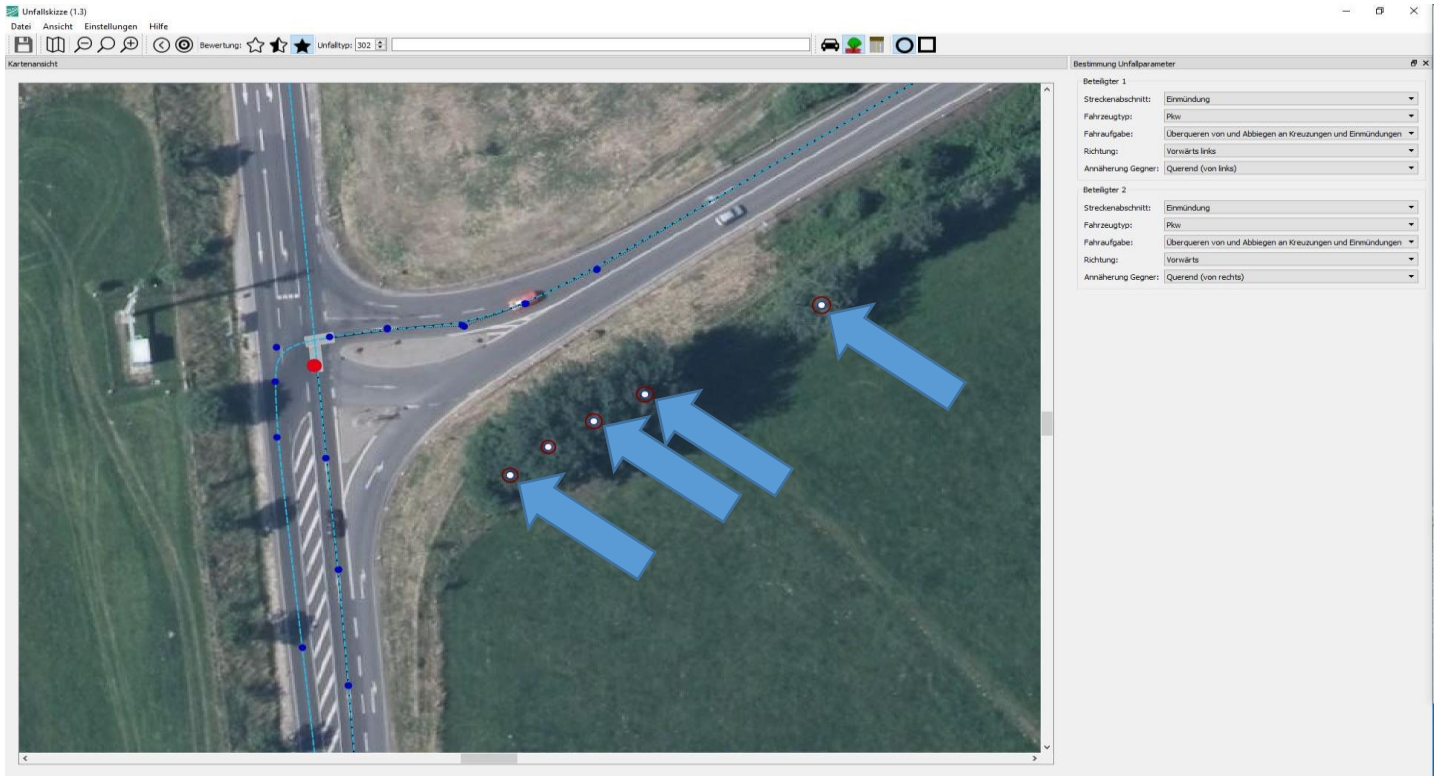
SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

Information added by Fraunhofer

- View obstacle (trees)





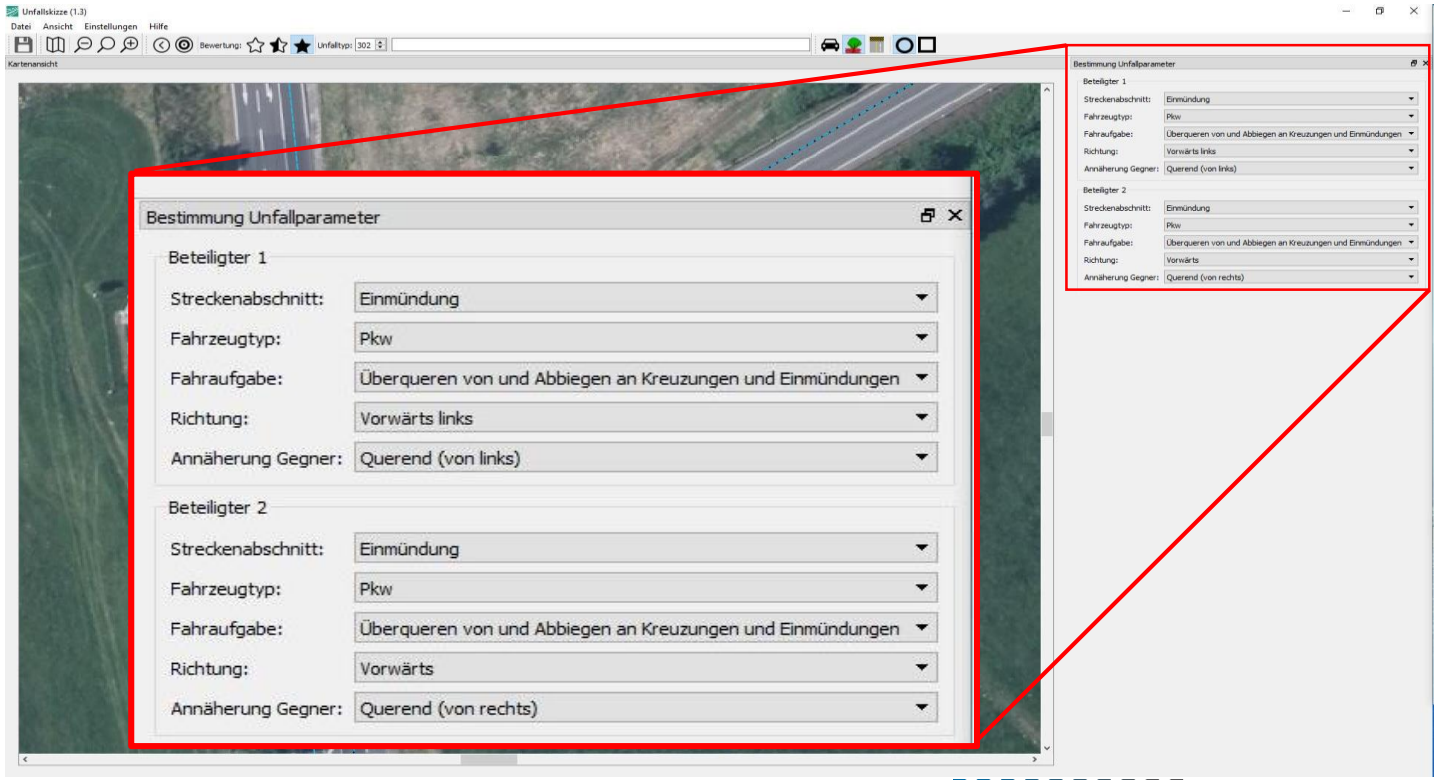
Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

Information added by Fraunhofer

- Logic description of participant behaviour



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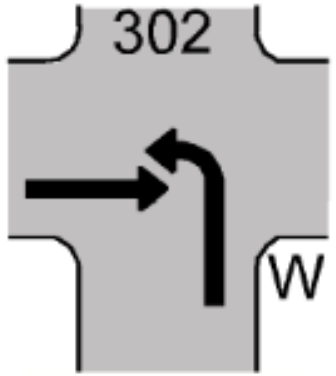
Martin Urban – Fraunhofer IVI

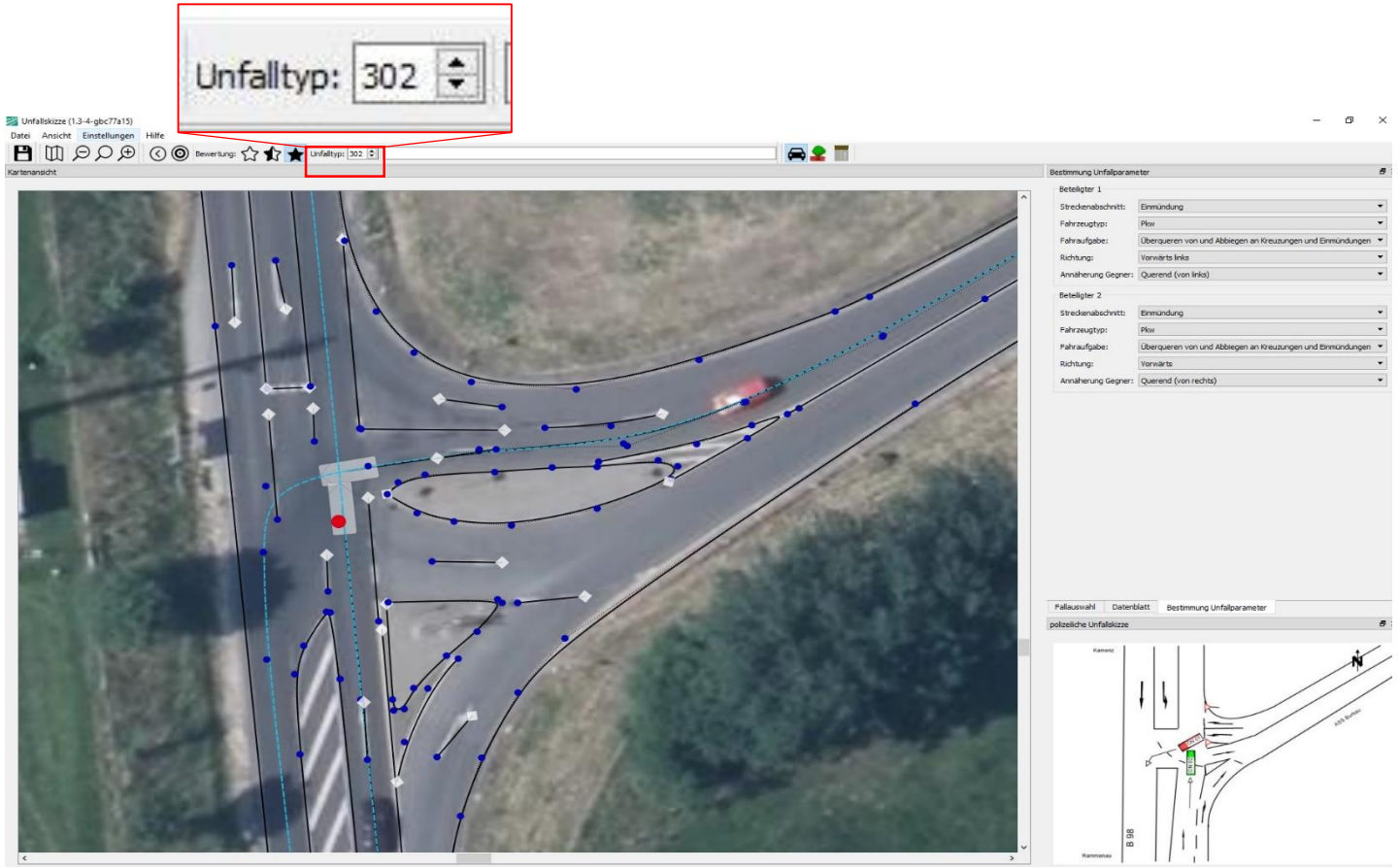
from police recorded accidents to simulation

Information added by Fraunhofer

- Logic description of participant behaviour
- 3-digit type of accident



(s.306)



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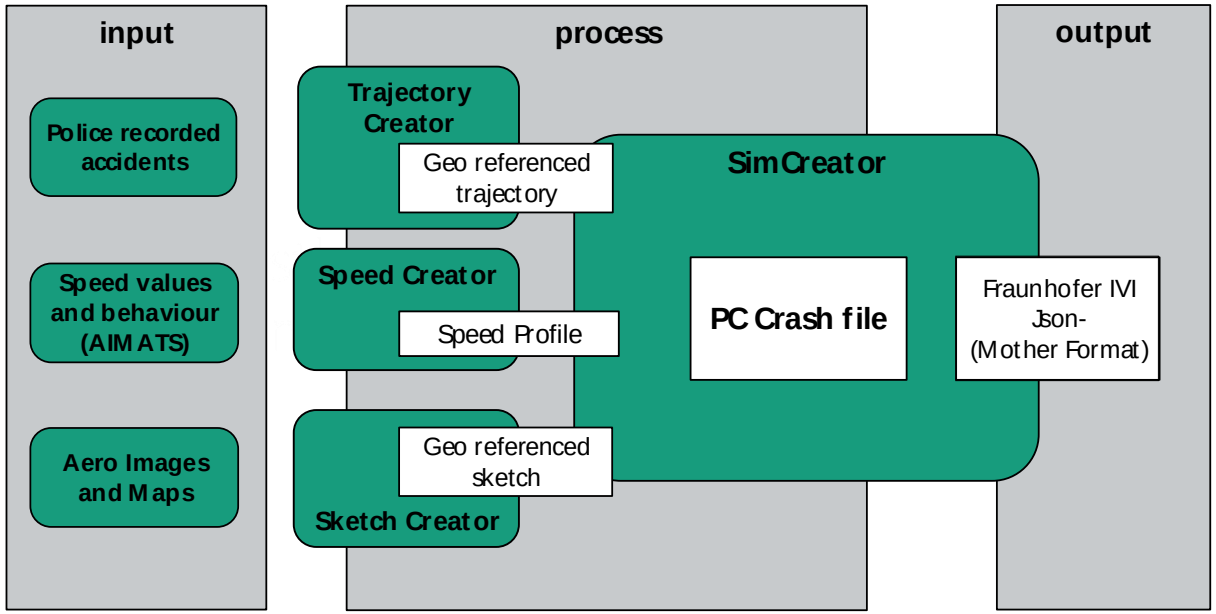
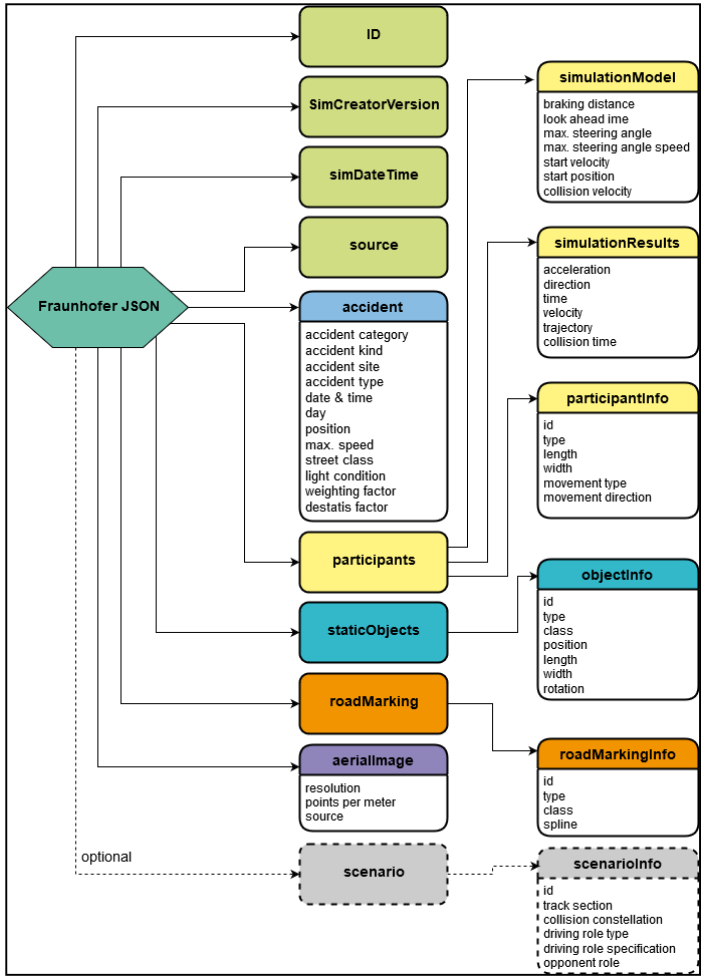
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

store simulation results





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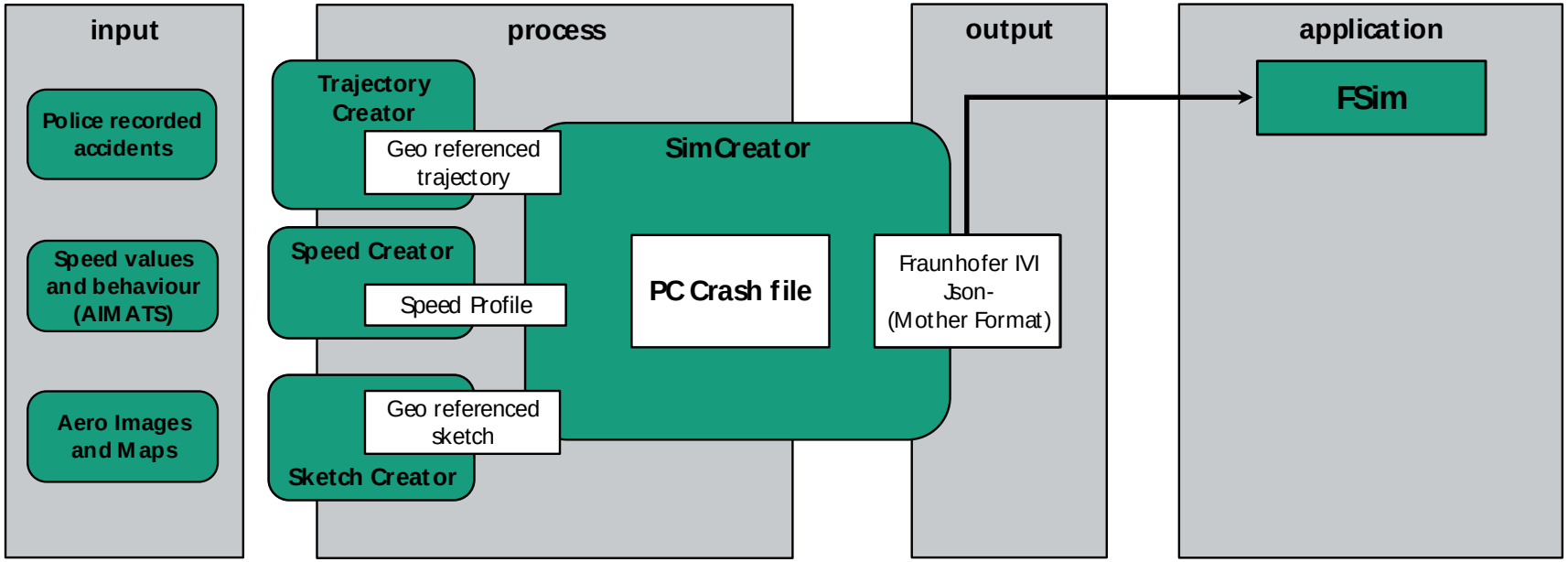
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

- use in simulation Fraunhofer Simulation (Fsim)



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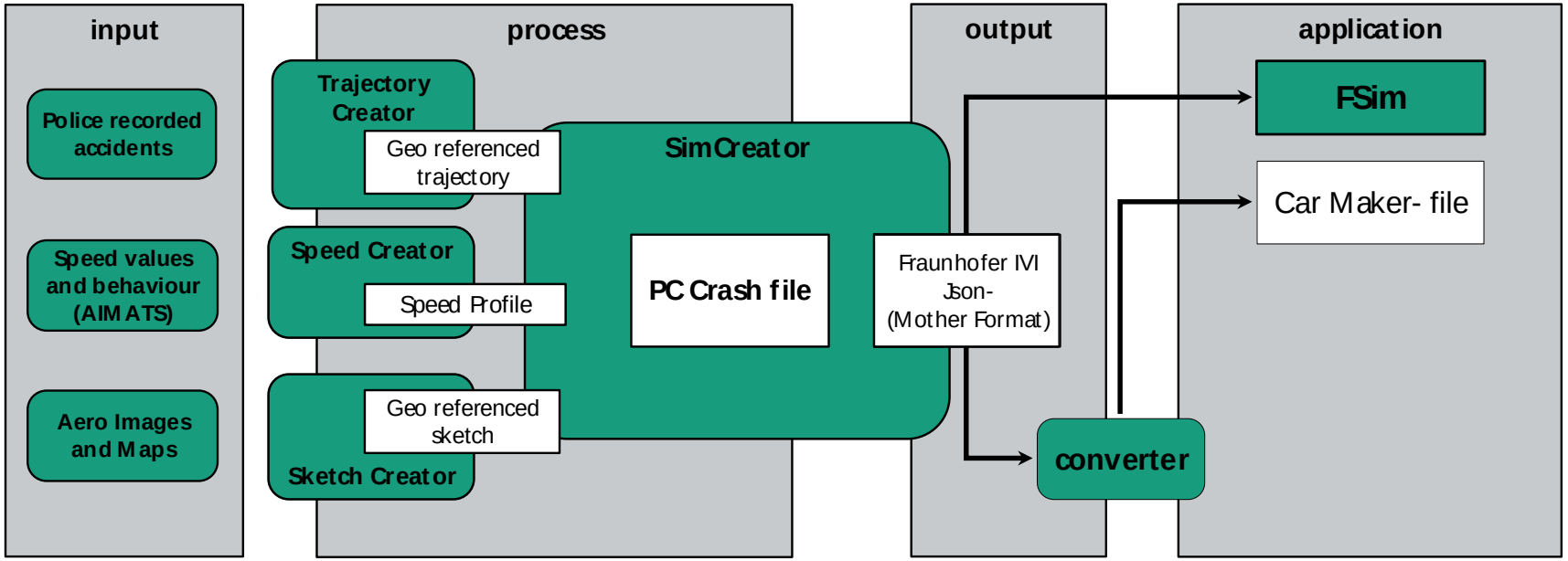
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

from police recorded accidents to simulation

- use in simulation IPG CarMaker



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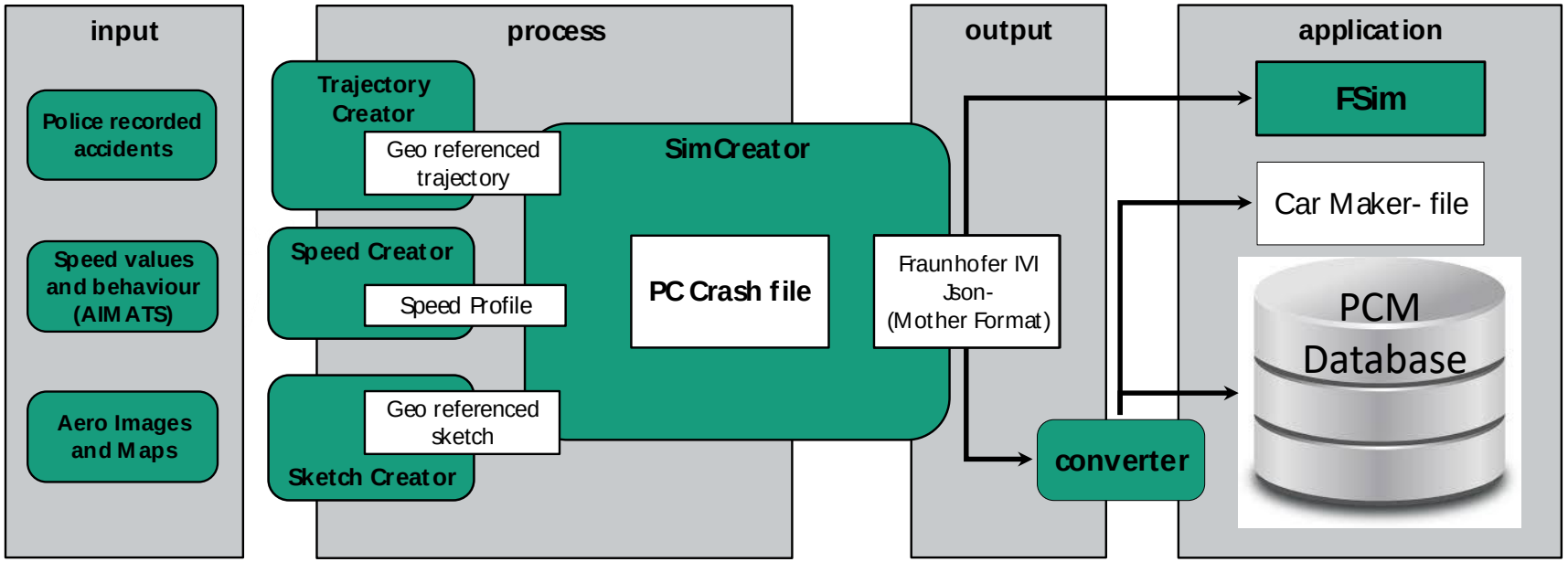
Martin Urban – Fraunhofer IVI

from police recorded accidents to simulation

- Store in PCM database



- 5.000 accidents per year
- 900 variations per accident

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Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

Testbed Dresden – Synchronized Mobility 2023

GIDAS
GERMAN IN-DEPTH ACCIDENT STUDY

Accident sketch

Vehicle dynamics

PCM Converter

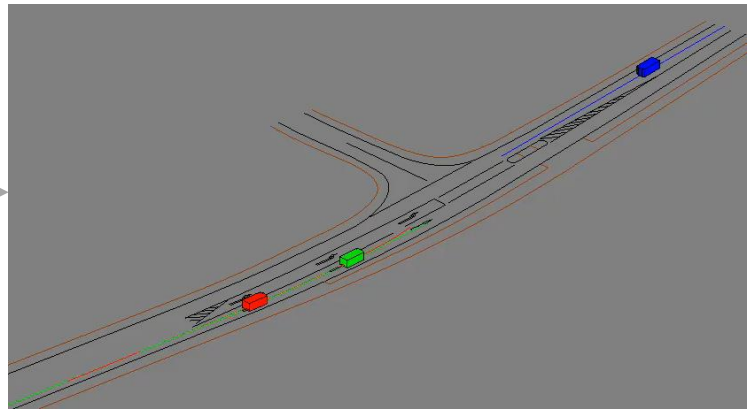
Conversion

of needed PCM information

Plausibility routines

Check of PC-CRASH results

GIDAS-PCM



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Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

Naturalistic Driving Study (NDS)

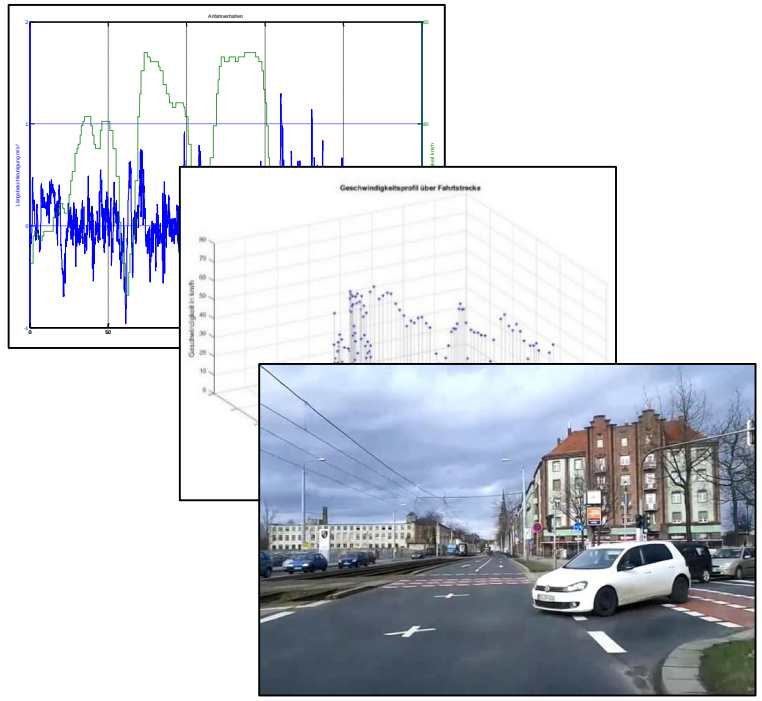
Recording ⇨ Processing ⇨ Digitalized Scenario

Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

Testbed Dresden – Synchronized Mobility 2023

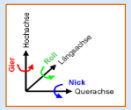
Recording → Processing → Digitalized Scenario

- Sensor data
  - Accelerometer
  - Rotation rate sensor
- GPS
- Camera
- Processor and ring memory



Position

Movement



Video

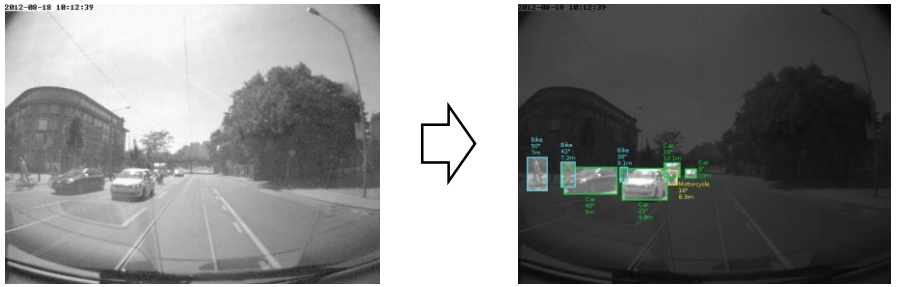
Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

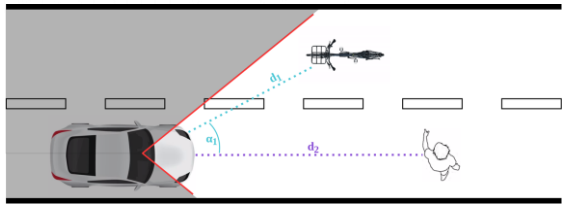
Testbed Dresden – Synchronized Mobility 2023

Recording → Processing → Digitalized Scenario

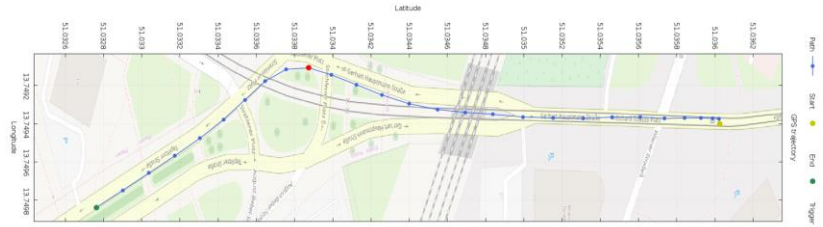
Object recognition and Object tracking



Distance estimation



GPS and map data



Methods and framework developed within the consortium of SePIA

SePIA PRÜF- UND TESTSZENARIEN

TECHNISCHE UNIVERSITÄT DRESDEN

PROFESSUR FÜR COMPUTERGRAPHIK UND VISUALISIERUNG

Prof. Dr. rer. nat. Gumhold

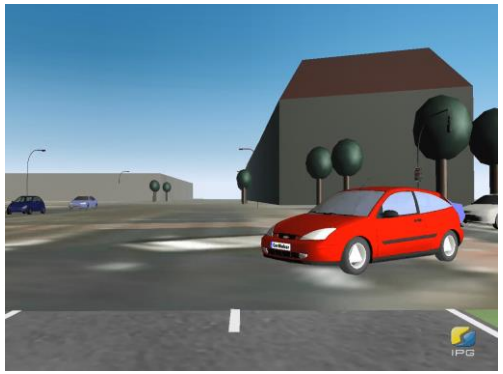
Europa fördert Sachsen. EFRE

Florian Spitzhüttl – VUFO GmbH
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

Testbed Dresden – Synchronized Mobility 2023

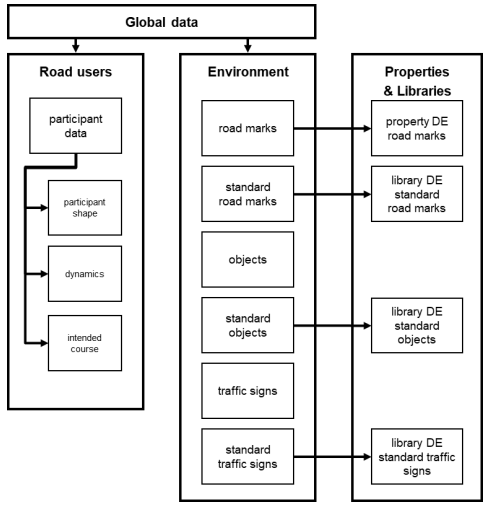
Recording → Processing → Digitalized Scenario



Parametrization / Detection of

- Ego vehicle
- Other participants
- Objects / buildings
- Road markings
- Traffic signs

PCM format



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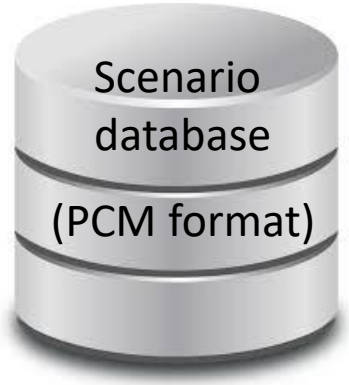
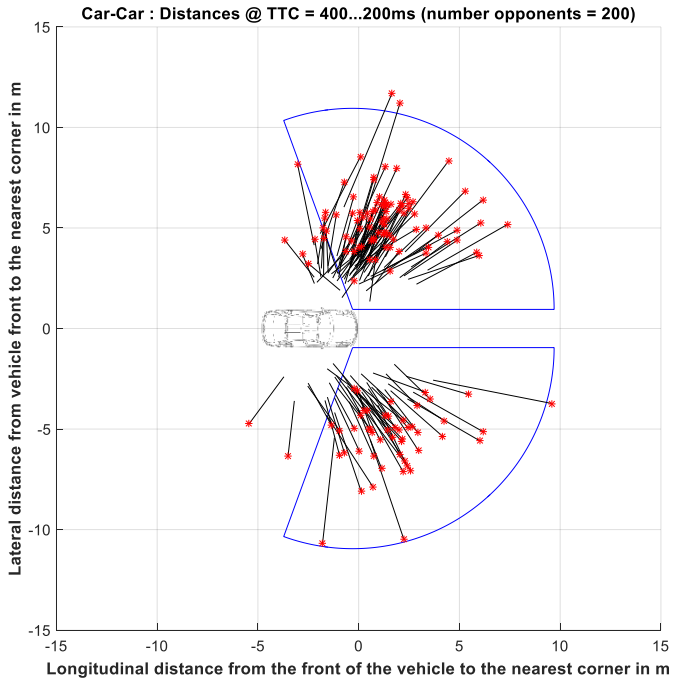
Martin Urban – Fraunhofer IVI

SYNCHRONE MOBILITÄT 2023

Application: evaluation of opponent's position at specific times





* 400 ms before crash
· 200 ms before crash

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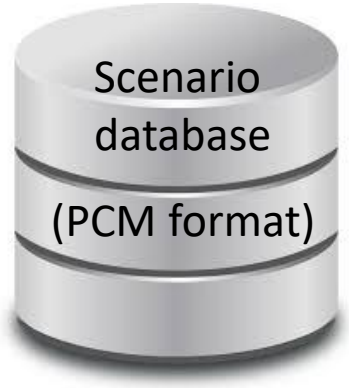
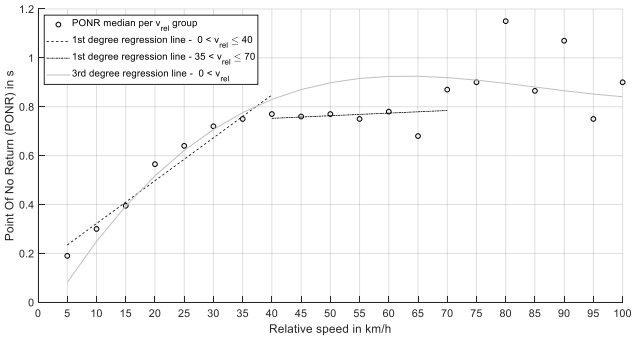
Application: assessment of scenario's criticality (e.g. Point Of No Return)



avoidance maneuvers

PONR[1]

as function of v_{rel}



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[1] F. Spitzhüttl; H. Liers. 2019. „Calculation of the Point Of No Return (PONR) from real-world accidents“, Enhanced Safety of Vehicles (ESV 2019).

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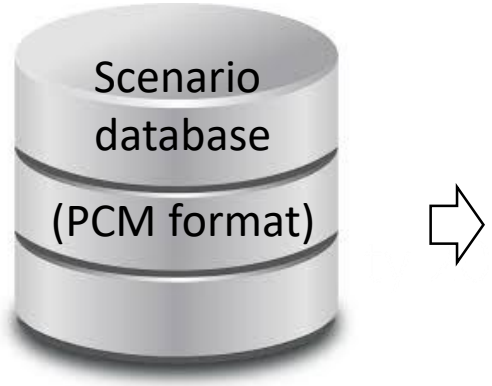
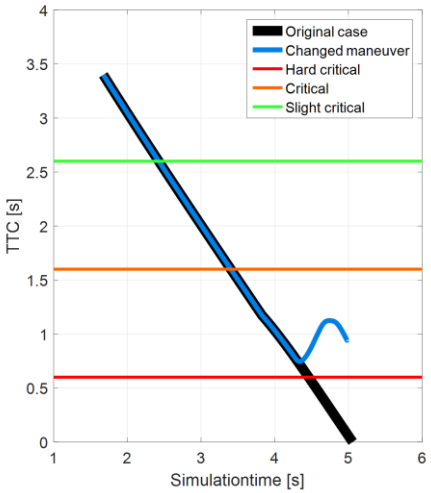
Application: assessment of scenario's criticality (e.g. Time To Collision)





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