L3Pilot
Driving Automation

KEY RESULTS

Hamburg 2021

Aria Etemad
Volkswagen Group Innovation

VOLKSWAGEN
AKTIENGESELLSCHAFT

L3Pilot Driving Automation

Objectives

1,000 drivers 100 cars 10 European countries Piloting Automated Driving on European Roads.

Methodology

Data

Evaluation

Fleet

Piloting

Code of Practice

PREPARE → DRIVE → EVALUATE

DEPLOY - Europe-wide Piloting Environment - User Studies - Business Studies


TRAFFIC JAM CHAUFFEUR


MOTORWAY CHAUFFEUR


PARKING CHAUFFEUR


URBAN CHAUFFEUR

Numbers, numbers, numbers

and an impressive portfolio of industry relevant results…

34 Project Partners

41 Work Packages

50 Months Duration

3,425 Person-months

479,500 Hours workload

5 Contract amendments

20 Deliverables

54 Presence @ Events

70+ Publications

20 Mailing lists

300 Experts on the contact list

250 Confluence Users

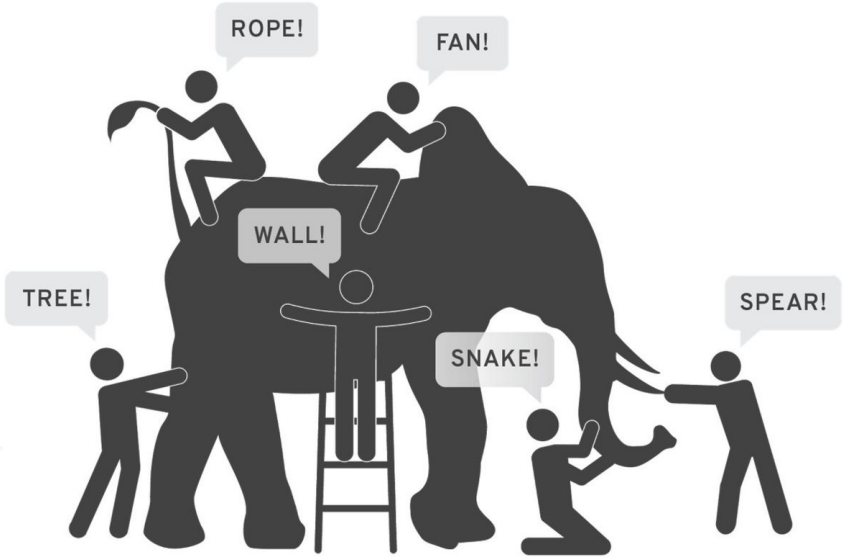
800 Twitter followers

28,000 Website visits

L3Pilot Driving Automation

Common technology understanding as a basis for development

#Automated driving evokes different connotations to different people as they understand it.



L3Pilot Driving Automation

Common technology understanding as a basis for development

L3Pilot glossaries

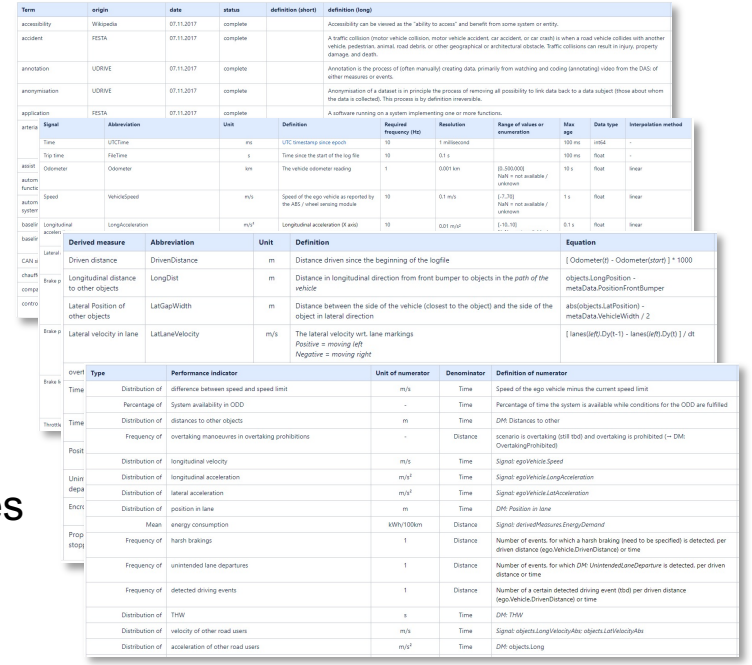
Semantic* - **150** definitions

*INPUT TO DIN SAE SPEC 91381 Terms & Def. Related to Testing of AV Technologies

Vehicle Signals - **120** entries

Derived measures (DMs) - **100** entries

Performance Indicators (PIs) - **100** entries



Term	origin	date	status	definition (short)	definition (long)
accessibility	Wikipedia	07.11.2017	complete		Accessibility can be viewed as the "ability to access" and benefit from some system or entity.
accident	FESTA	07.11.2017	complete		A traffic collision (motor vehicle collision, motor vehicle accident, car accident, or car crash) is when a road vehicle collides with another vehicle, pedestrian, animal, road debris, or other geographical or architectural obstacle. Traffic collisions can result in injury, property damage, and death.
annotation	UDRIVE	07.11.2017	complete		Annotation is the process of (often manually) creating data, primarily from watching and coding (annotating) video from the DAS of either measures or events.
anonymisation	UDRIVE	07.11.2017	complete		Anonymisation of a dataset is in principle the process of removing all possibility to link data back to a data subject (those about whom the data is collected). This process is by definition irreversible.
application	FESTA	07.11.2017	complete		A software running on a system implementing one or more functions.

Signal	Abbreviation	Unit	Definition	Required frequency (Hz)	Resolution	Range of values or enumeration	Max age	Data type	Interpolation method
Time	UTCTime	ms	UTC timestamp since epoch	10	1 millisecond		100 ms	int64	-
Trip time	FileTime	s	Time since the start of the log file	10	0.1 s		100 ms	float	-
Odometer	Odometer	km	The vehicle odometer reading	1	0.001 km	[0..500.000] NaN = not available / unknown	10 s	float	linear
Speed	VehicleSpeed	m/s	Speed of the ego vehicle as reported by the ABS / wheel sensing module	10	0.1 m/s	[-7..70] NaN = not available / unknown	1 s	float	linear
Longitudinal acceler...	LongAcceleration	m/s²	Longitudinal acceleration (X axis)	10	0.01 m/s²	[-10..10]	0.1 s	float	linear

Derived measure	Abbreviation	Unit	Definition	Equation
Driven distance	DrivenDistance	m	Distance driven since the beginning of the logfile	[Odometer(t) - Odometer(*start*)] * 1000
Longitudinal distance to other objects	LongDist	m	Distance in longitudinal direction from front bumper to objects in the *path of the vehicle*	objects.LongPosition - metaData.PositionFrontBumper
Lateral Position of other objects	LatGapWidth	m	Distance between the side of the vehicle (closest to the object) and the side of the object in lateral direction	abs(objects.LatPosition) - metaData.VehicleWidth / 2
Lateral velocity in lane	LatLaneVelocity	m/s	The lateral velocity wrt. lane markings *Positive = moving left* *Negative = moving right*	[lanes(*left*).Dy(t-1) - lanes(*left*).Dy(t)] / dt

Type	Performance indicator	Unit of numerator	Denominator	Definition of numerator
Distribution of	difference between speed and speed limit	m/s	Time	Speed of the ego vehicle minus the current speed limit
Percentage of	System availability in ODD	-	Time	Percentage of time the system is available while conditions for the ODD are fulfilled
Distribution of	distances to other objects	m	Time	*DM: Distances to other*
Frequency of	overtaking manoeuvres in overtaking prohibitions	-	Distance	scenario is overtaking (still tbd) and overtaking is prohibited (← DM: OvertakingProhibited)
Distribution of	longitudinal velocity	m/s	Time	*Signal: egoVehicle.Speed*
Distribution of	longitudinal acceleration	m/s²	Time	*Signal: egoVehicle.LongAcceleration*
Distribution of	lateral acceleration	m/s²	Time	*Signal: egoVehicle.LatAcceleration*
Distribution of	position in lane	m	Time	*DM: Position in lane*
Mean	energy consumption	kWh/100km	Distance	*Signal: derivedMeasures.EnergyDemand*
Frequency of	harsh brakings	1	Distance	Number of events, for which a harsh braking (need to be specified) is detected, per driven distance (ego.Vehicle.DrivenDistance) or time
Frequency of	unintended lane departures	1	Distance	Number of events, for which *DM: UnintendedLaneDeparture* is detected, per driven distance or time
Frequency of	detected driving events	1	Distance	Number of a certain detected driving event (tbd) per driven distance (ego.Vehicle.DrivenDistance) or time
Distribution of	THW	s	Time	*DM: THW*
Distribution of	velocity of other road users	m/s	Time	*Signal: objects.LongVelocityAbs; objects.LatVelocityAbs*
Distribution of	acceleration of other road users	m/s²	Time	*DM: objects.Long*

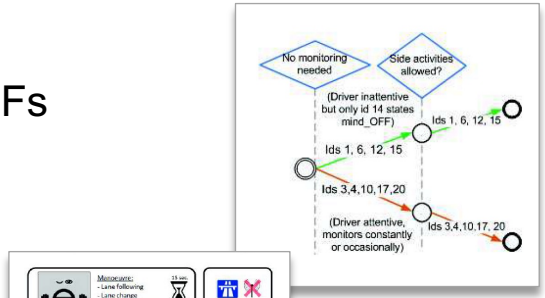
L3Pilot contribution to industry's widely and often-debated **Operational Design Domain (ODD)**

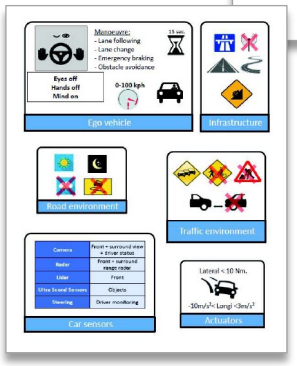
Taxonomy of Automated Driving Functions (ADFs)

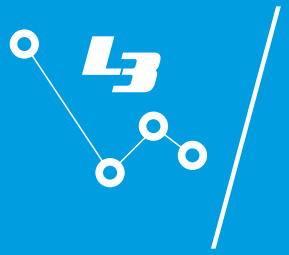
Individual presentation of ADFs

Overlapping conditions

Definition of ODD factors





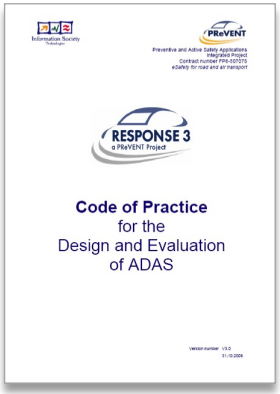


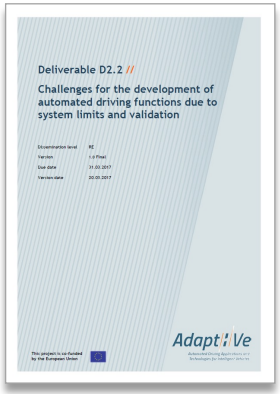
Code of Practice

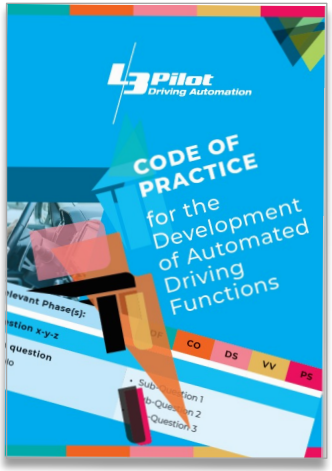
FINAL EVENT Hamburg 2021

L3Pilot Driving Automation

History of the **Code of Practice (CoP)**







PReVENT
RESPONSE 3 „CoP ADAS“

2008

AdaptIVe
Response 4 „Legal aspects AD“

2014 2017

L3Pilot
„CoP-ADF“

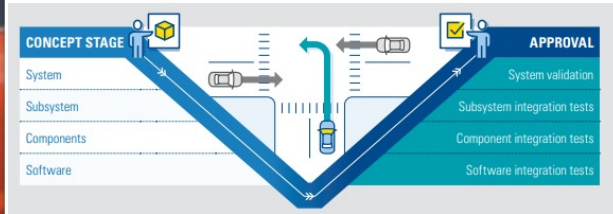
2017 2021

L3Pilot contribution to industry's Operational Design Domain

Categories of the CoP according to D2.1 "Code of Practice Framework":

Operational Design Domain Vehicle Level	**Operational Design Domain Traffic System Level**	**Safe Guarding Automation**	**Human-Machine Integration**	**Behavioral Design**
				
Function description, system limits, test-/ scenario catalogue	Remote assistance, V2X, MRM etc.	Functional safety, cyber security, SOTIF, updates (e.g. over the air) etc.	Provide guidelines for HMI, mode awareness/ confusion, controllability etc.	Traffic safety (mixed traffic), references to Ethics

First steps towards a EU-wide admission procedure: **CoP for road testing**



Forum of leading European member states and industry stakeholders established

L3Pilot Driving Automation

Methodology

The EU tradition brought to the **next level: FESTA for automated driving tests**

128 research questions across all evaluation areas

70 Derived Measures (DMs)

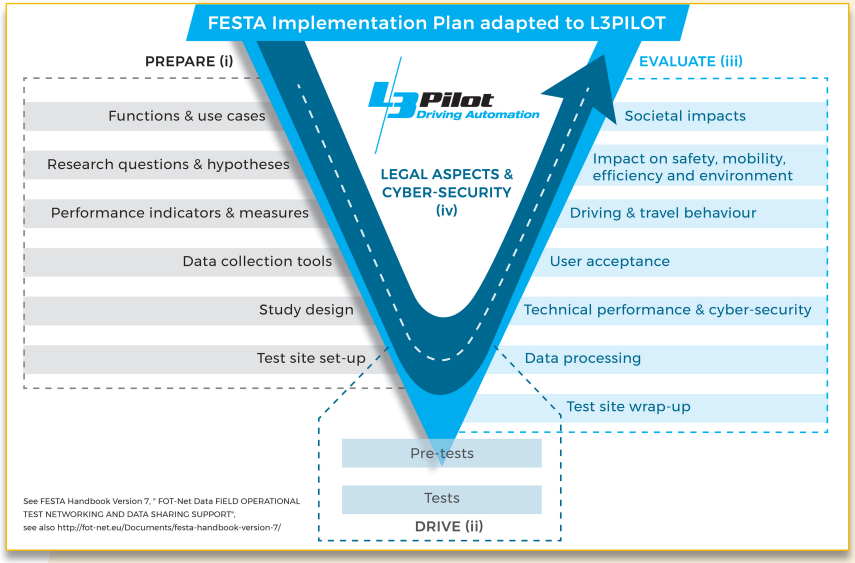
60 Performance Indicators (PIs)

100 vehicle signals

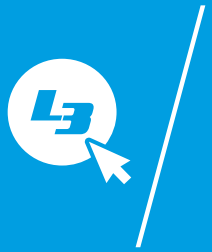
Data logging requirements & tools

Scenario-based evaluation tools

Scale-up of impacts EU level



L3Pilot Driving Automation



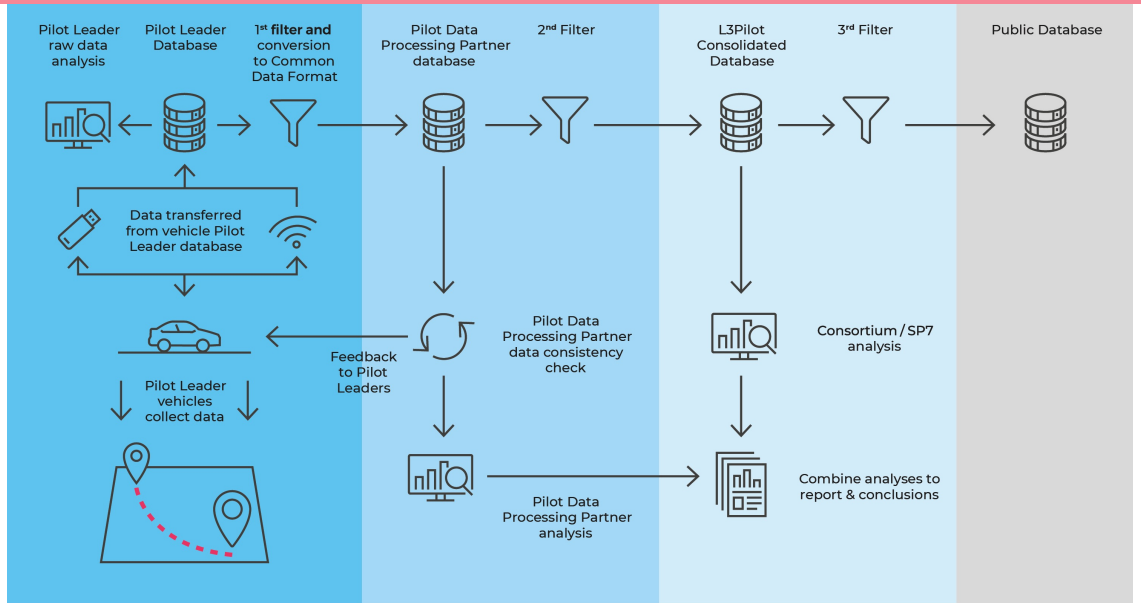
Data

FINAL EVENT Hamburg 2021

Pilot Driving Automation

From numbers to processes L3Pilot data handling & sharing

Pipeline from data collection to a project-wide tool chain for vehicle-data analysis

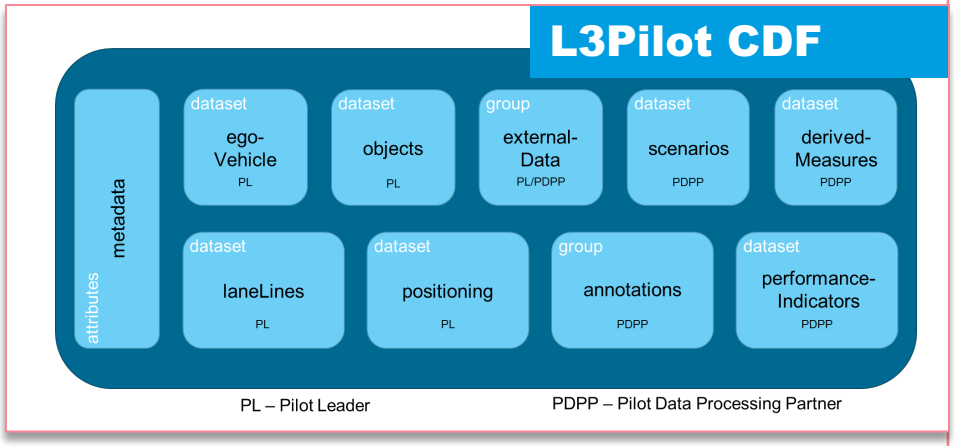


Public: **L3Pilot Common Data Format (CDF)**

The CDF is made available to the public via Github: github.com/l3pilot/l3pilot-cdf.

Everyone is invited to use the format and contribute to it.

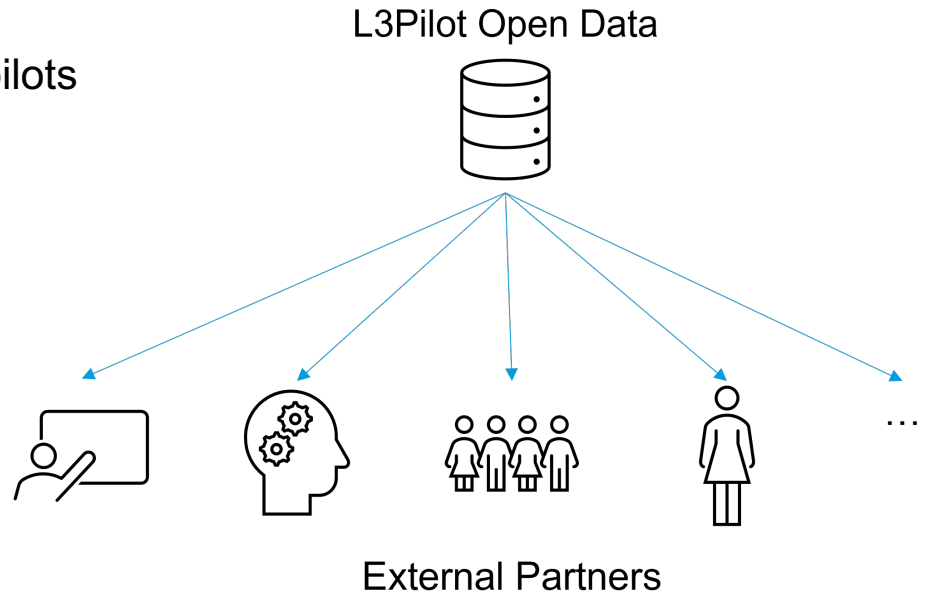
Use open source tools and formats to facilitate use in other projects.



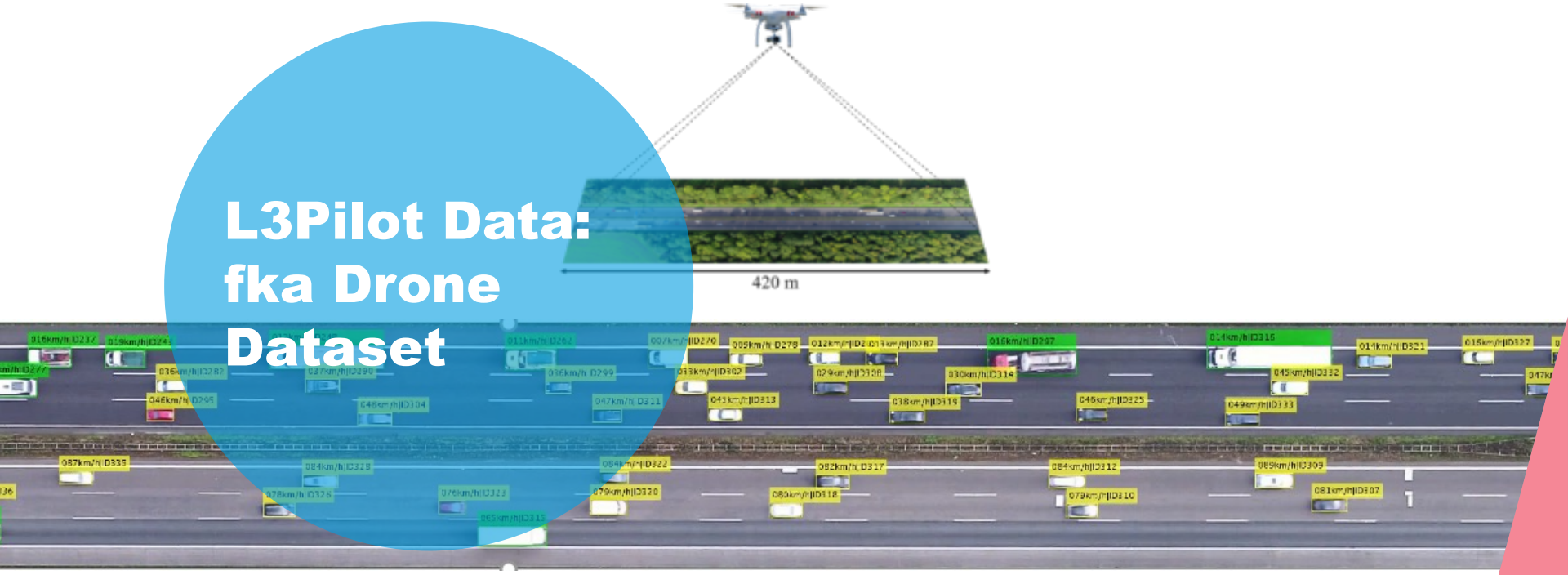
Public: **L3Pilot Open Data**

https://l3pilot.eu/data/

- Anonymised vehicle data from the pilots
- User acceptance survey data
- Datasets from individual partners



L3Pilot Open Data: examples



L3Pilot Data: fka Drone Dataset

Fleet

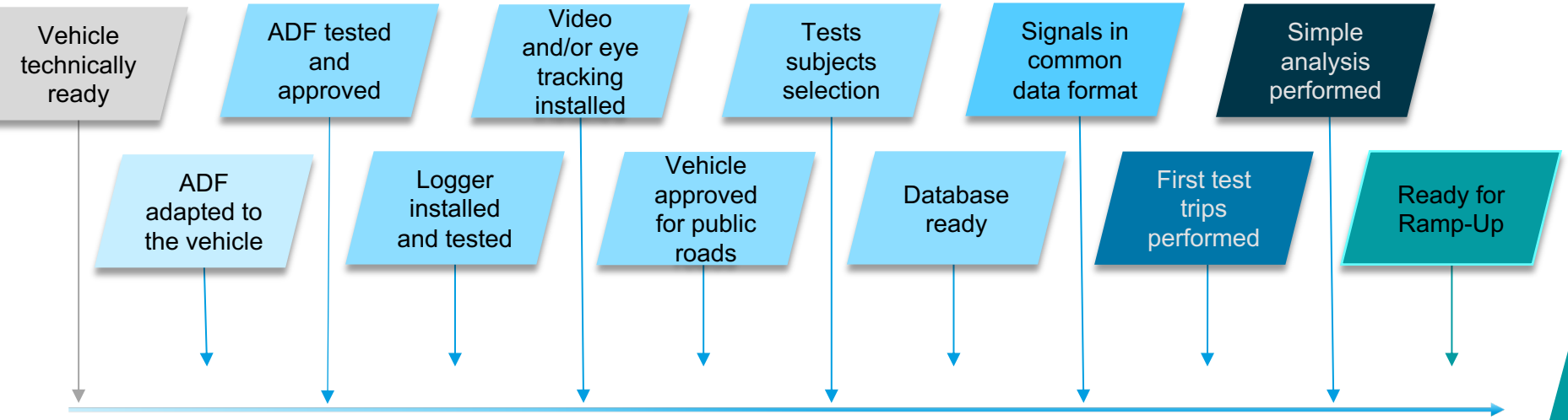
FINAL EVENT Hamburg 2021

L3Pilot Driving Automation

From processes to hand-on preparation and testing

Joint European effort to boost automated driving: **70+** vehicles fully equipped

Pan-European testing environment: **14** vehicle owners, **7** countries



L3Pilot Driving Automation


Flipping the odds
L3Pilot
Driving Automation
1000
drivers
100
cars
10
countries

Flipping the odds

User study during a pandemic: filling in a questionnaire – with mask, gloves and distance

Pilot execution despite COVID crisis

Plastic foil separation between driver and passenger area during piloting of Volkswagen AG

L3Pilot Driving Automation

Piloting

FINAL EVENT Hamburg 2021

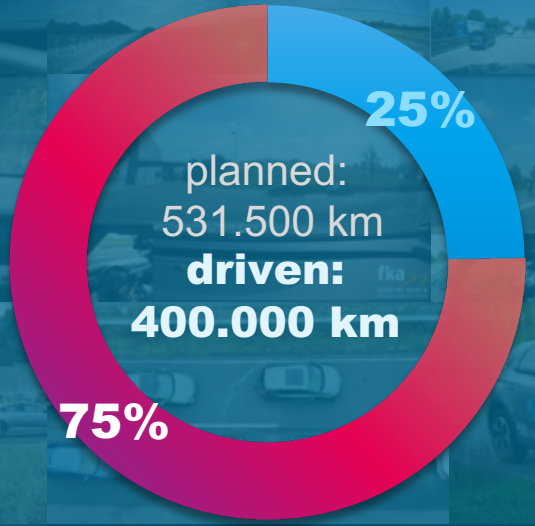
L3Pilot Driving Automation

On the road – **against all odds**

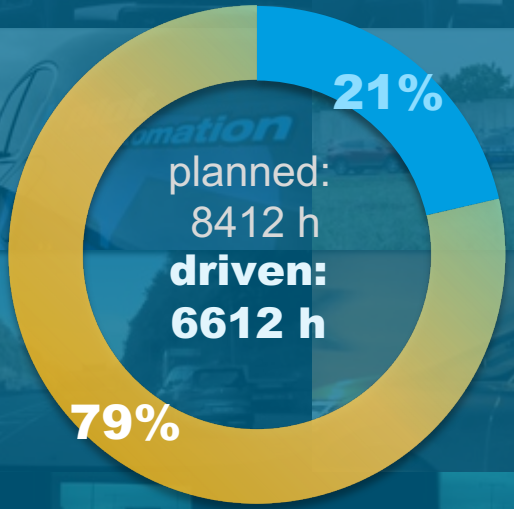

On the road – against all odds
fka
STADTRUNDFAHRT

Pilot execution

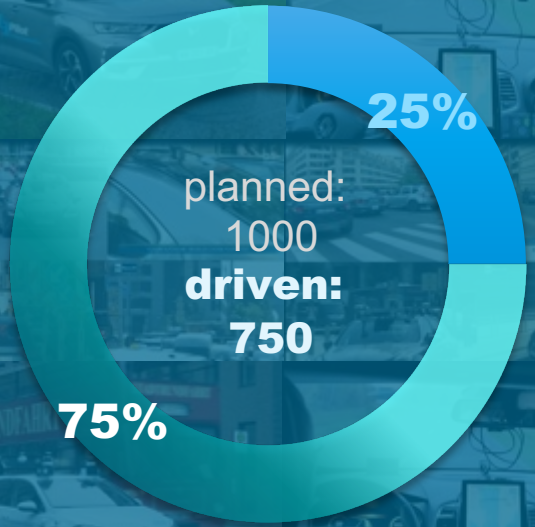
KILOMETERS



HOURS OF DRIVING

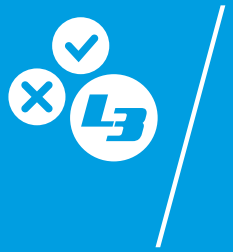


SUBJECTS



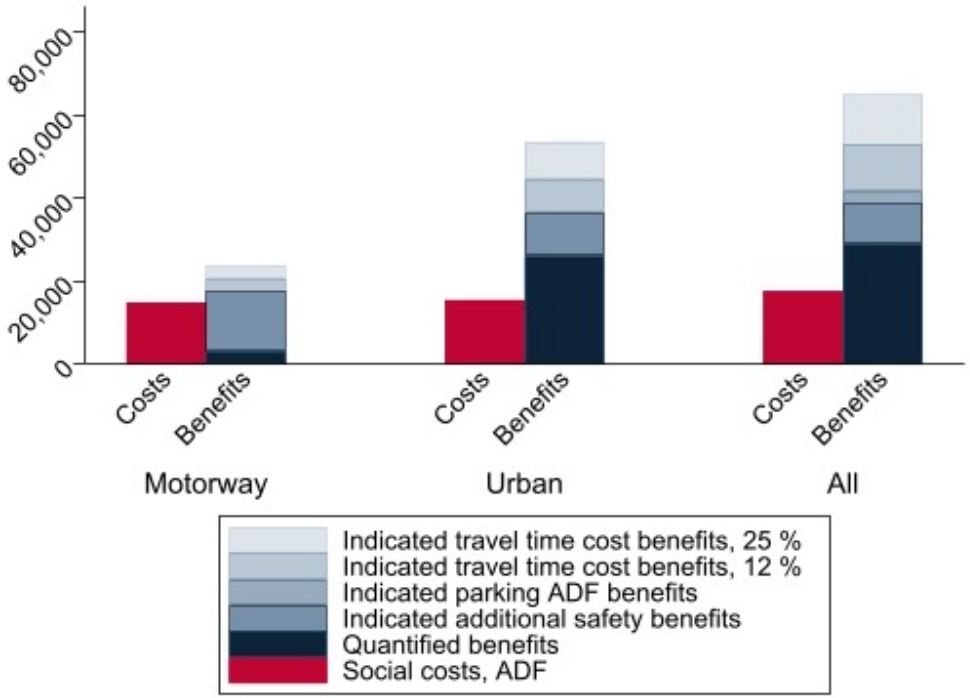
› 75%
DONE

+ 600 persons supplementary studies



Evaluation

Socio-economic impact assessment: benefits outweigh costs



Social benefits exceed the cost of implementing the system.

L3 ADFs profitable from the society's point of view.

FINAL EVENT Hamburg 2021

L3Pilot User Acceptance Survey

Online survey on user acceptance of SAE Level 3: Conditionally automated cars

Long term perspective study // global

5 continents **17** countries

Data Collection in 3 waves:

05-06/2019 | 02-03/2020 | 01-02/2021

27,970 car drivers surveyed:

Wave 1 n = 9, 118 | Wave 2 n = 9, 513 |

Wave 3 n = 9, 339

L3Pilot Driving Automation

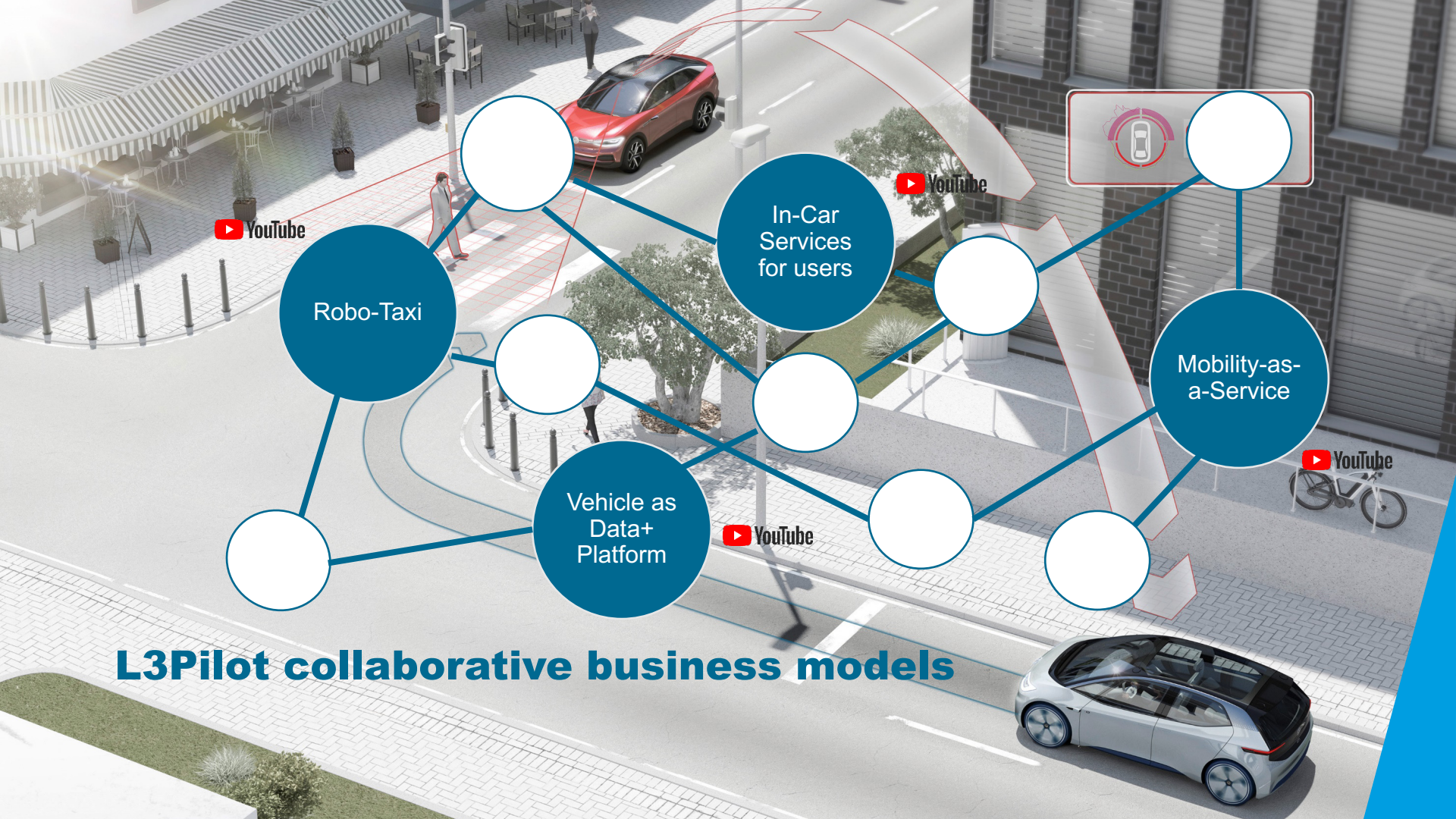
L3Pilot User Acceptance Survey

Interdisciplinary, cross-national expert group to:

Develop survey concept, methodological approach, and questionnaire

Share data, check quality and discuss insights

Derive target-group specific presentation of results

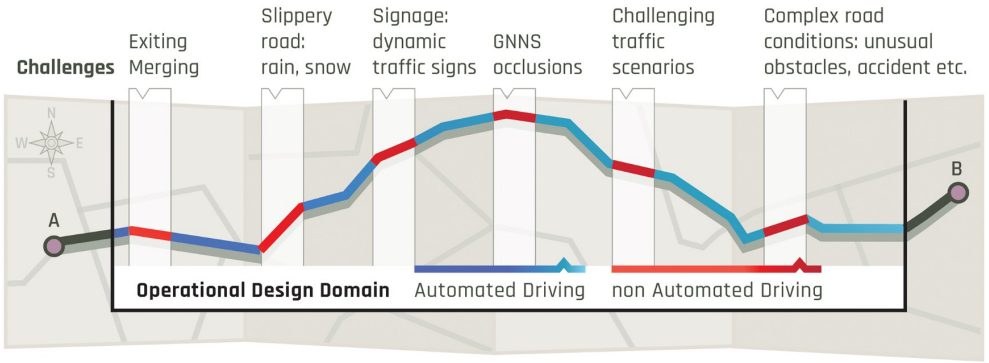


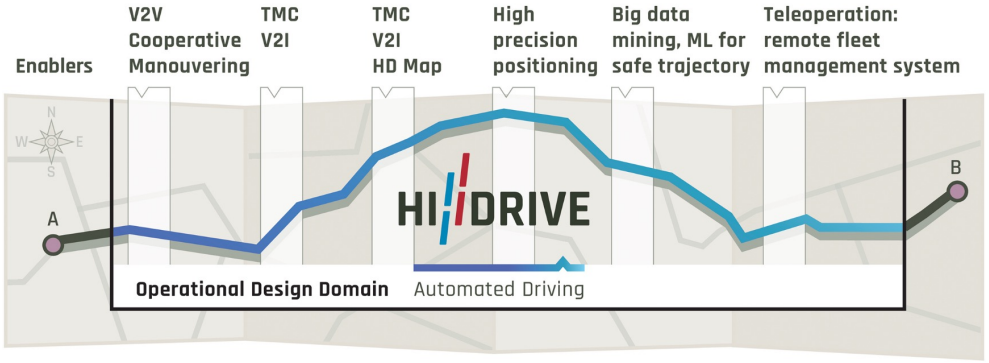
L3Pilot collaborative business models

Challenges toward the deployment of higher automation identified

How can fragmentations in ODDs be eliminated?

Extended & Continuous ODDs on interoperable European roads





The team behind L3Pilot

Day 1, October 13

09:00 – 10:00 Opening Session		
09:00 – 09:10	L3Pilot – the Flagship Project	**Aria Etemad,** Coordinator L3Pilot, Volkswagen AG
09:10 – 09:20	A Bright Future of Mobility	**Nikolai Ardey,** Executive Director Group Innovation, Volkswagen AG
09:20 – 09:30	EU Vision and Strategy for CCAM	**Tom Alkim,** Policy Officer, European Commission at DG RTD
09:30 – 09:40	Smart and sustainable mobility – a EUCAR perspective	**Stefan Deix,** Director European Council for Automotive R&D – EUCAR
09:40 – 10:00	L3Pilot Key Results	**Aria Etemad,** Coordinator L3Pilot, Volkswagen AG
10:00 – 11:00 Break and Exhibition		
11:00 – 12:30 Harmonisation: Frame the Path		
11:00 – 11:30	Code of Practice	**Yves Page,** Project Leader Automated Driving Experiments, Renault Group
11:30 – 11:50	Piloting Automated Driving	**Luisa Andreone,** Programme Manager, Automation & Connectivity, Stellantis-CRF
11:50 – 12:20	Data Handling & Sharing	**Johannes Hiller,** Group Leader Data & Intelligent Infrastructure, ika
12:20 – 12:30	Methodology & Evaluation	**Satu Innamaa,** Principal Scientist, VTT **Hendrik Weber,** Specialist Scenario-based V&V, ika
12:30 – 14:00 Lunch, Networking and Exhibition		
14:00 – 14:40	Overall Methodology and Evaluation Framework	**Satu Innamaa,** Principal Scientist, VTT **Hendrik Weber,** Specialist Scenario-based V&V, ika
14:40 – 15:30	Technical & Traffic Evaluation	**Barbara Metz,** Research Scientist, WIVW **Johannes Hiller,** Group Leader Data & Intelligent Infrastructure, ika
15:30 – 16:00 Break		
16:00 – 17:00	Technical & User Evaluation	**Barbara Metz,** Research Scientist, WIVW
	User & Acceptance Evaluation	**Tyron Louw,** Senior Research Fellow, Institute for Transport Studies, University of Leeds **Marco Dozza,** Professor in Division Vehicle Safety, Chalmers University
17:00 – 17:15 Break		
17:15 – 18:15	L3Pilot Published Databases	**Hendrik Weber,** Specialist Scenario-based V&V, ika
	AIM Mobile Traffic Acquisition System Analysis	**Michael Boehm,** Senior Researcher, DLR
18:30 – 19:30 Reception at the L3Pilot Exhibition		

Day 2, October 14

09:00 – 09:10	EU Support for Large-Scale Cooperation	**Marcel Rommerts,** Head of Unit – Transport Research, European Commission, CINEA
09:10 – 10:30	Supplementary Studies with Simulators and Wizard of Oz Vehicles	**Tyron Louw,** Senior Research Fellow, Institute for Transport Studies, University of Leeds **Barbara Metz,** Research Scientist, WIVW **Alexander Zerbe,** Researcher, BASt **Linda Pipkorn,** PhD Student, Chalmers University **Johanna Wörle,** Research Scientist, WIVW
10:30 – 11:00 Break		
11:00 – 11:30	Mobility Impact Assessment	**Esko Lehtonen,** Senior Scientist, VTT
11:30 – 12:30	Efficiency and Environmental Impact Assessment	**Elina Aittoniemi,** Senior Scientist, VTT **Teemu Itkonen,** Research Scientist, VTT **Michael Schuldes,** Research Assistant, ika
12:30 – 14:00 Lunch & Exhibition		
14:00 – 15:30	Safety Impact Assessment: Quantitative & Qualitative	**Felix Fahrenkrog,** Expert, BMW **Marco Dozza,** Professor in Division Vehicle Safety, Chalmers University **Hendrik Weber,** Specialist Scenario-based V&V, ika **Marcel Borrack,** Accident Research Expert, AZT **Yves Page,** Project Leader Automated Driving Experiments, Renault Group
15:30 – 16:00 Break		
16:00 – 17:00	Safety Impact Assessment: Scaling up to European Level	**Anne Silla,** Research Team Leader, VTT
	Socio-economic Impact Assessment	**Afsaneh Bjorvatn,** Senior Researcher, SNF
	Wrap Up of Impact Assessment	**Yves Page,** Project Leader Automated Driving Experiments, Renault Group **Hendrik Weber,** Specialist Scenario-based V&V, ika
17:00 – 17:15 Break		
17:15 – 17:45	International L3 User Acceptance Survey	**Tanja Kessel,** Managing Director, EICT
17:45 – 18:15	Collaborative Business Models for Automated Driving	**Frank Berkers,** Senior Scientist, TNO **David Ertl,** EU Project Officer, FIA **Eckhard Schueler-Hainsch,** Innovation Manager, EICT
18:15 – 18:30	Outlook: Towards Deployment of High Automation	**Aria Etemad,** Coordinator L3Pilot, Volkswagen AG
18:30 End of the Final Event		

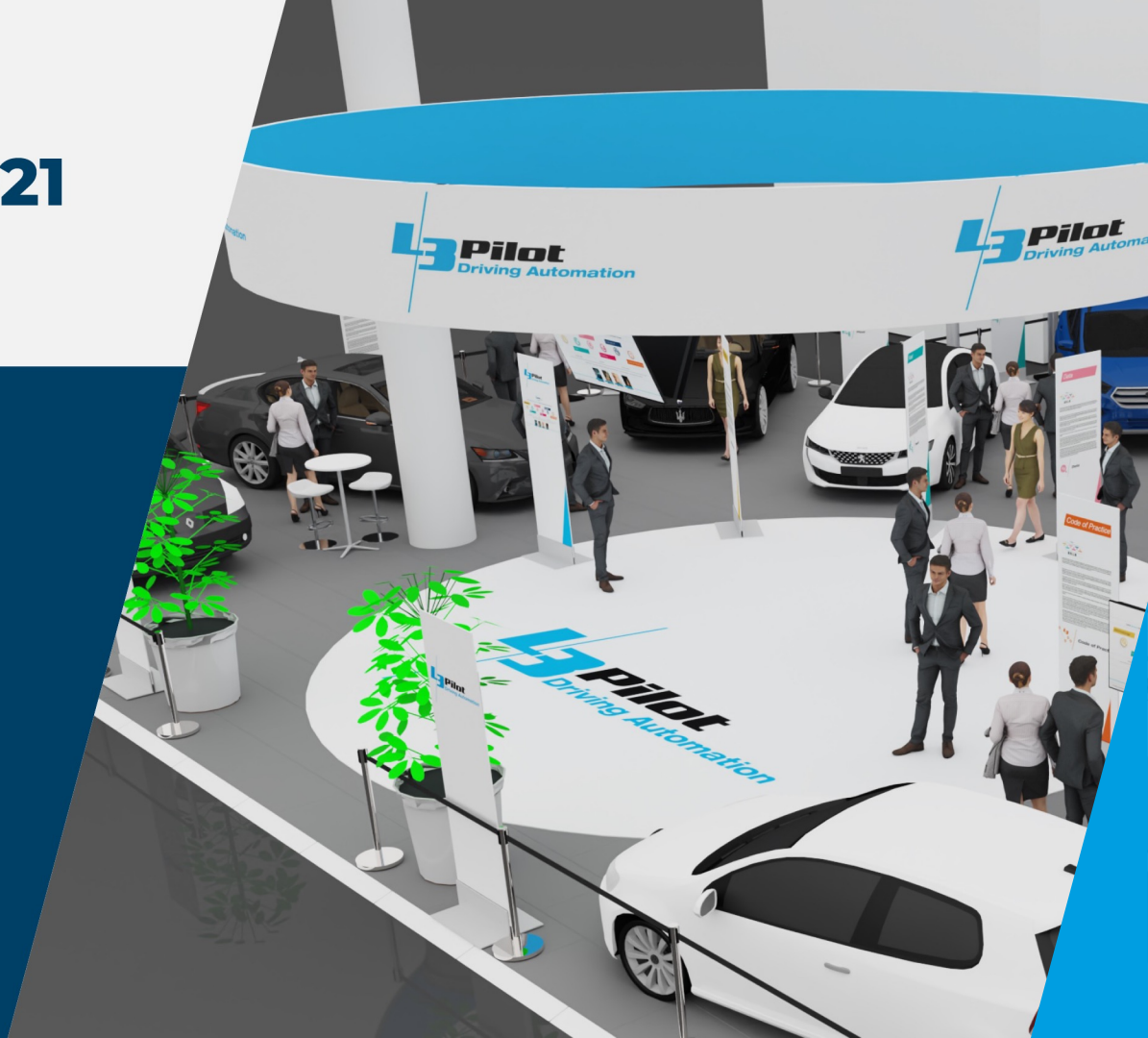
L3Pilot Driving Demonstrations
October 11 – 15, 2021

Motorway Demonstration

Urban Demonstration

L3Pilot Exhibition
October 11 – 15, 2021

GET TOGETHER
at Booth B3EG01
on Wednesday,
October 13, 18:15!



Thank you for your kind attention.

Aria Etemad
Volkswagen Group Innovation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723051.

L3Pilot Driving Automation

FINAL EVENT

Hamburg 2021

ITS World Congress