Hi-Drive
Designing Automation

ROADSHOW #2

Precise Positioning and localization inside Tunnel Rennsteig

Hi-Drive Webinar 02 – 22.09.2023

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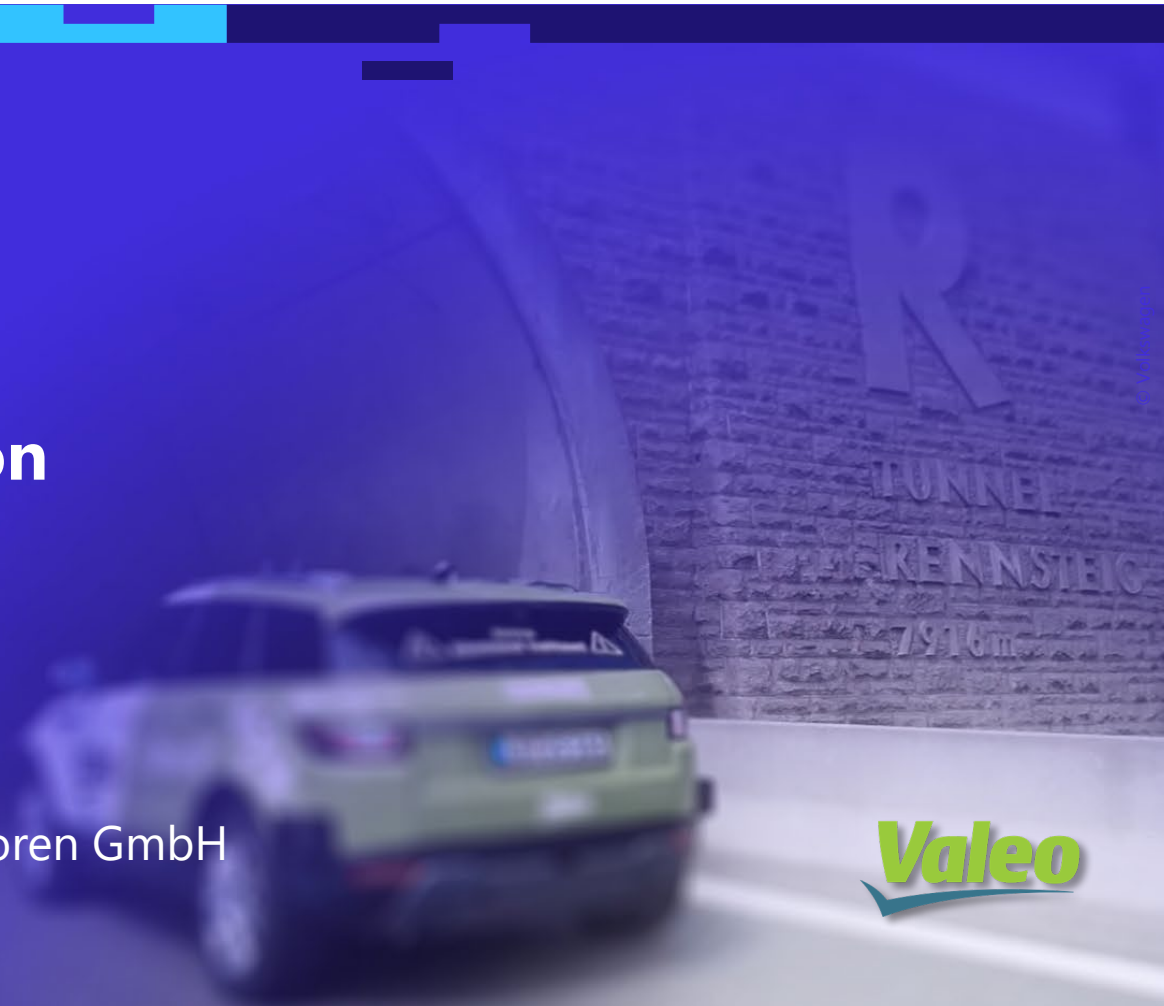


Valeo

Agenda

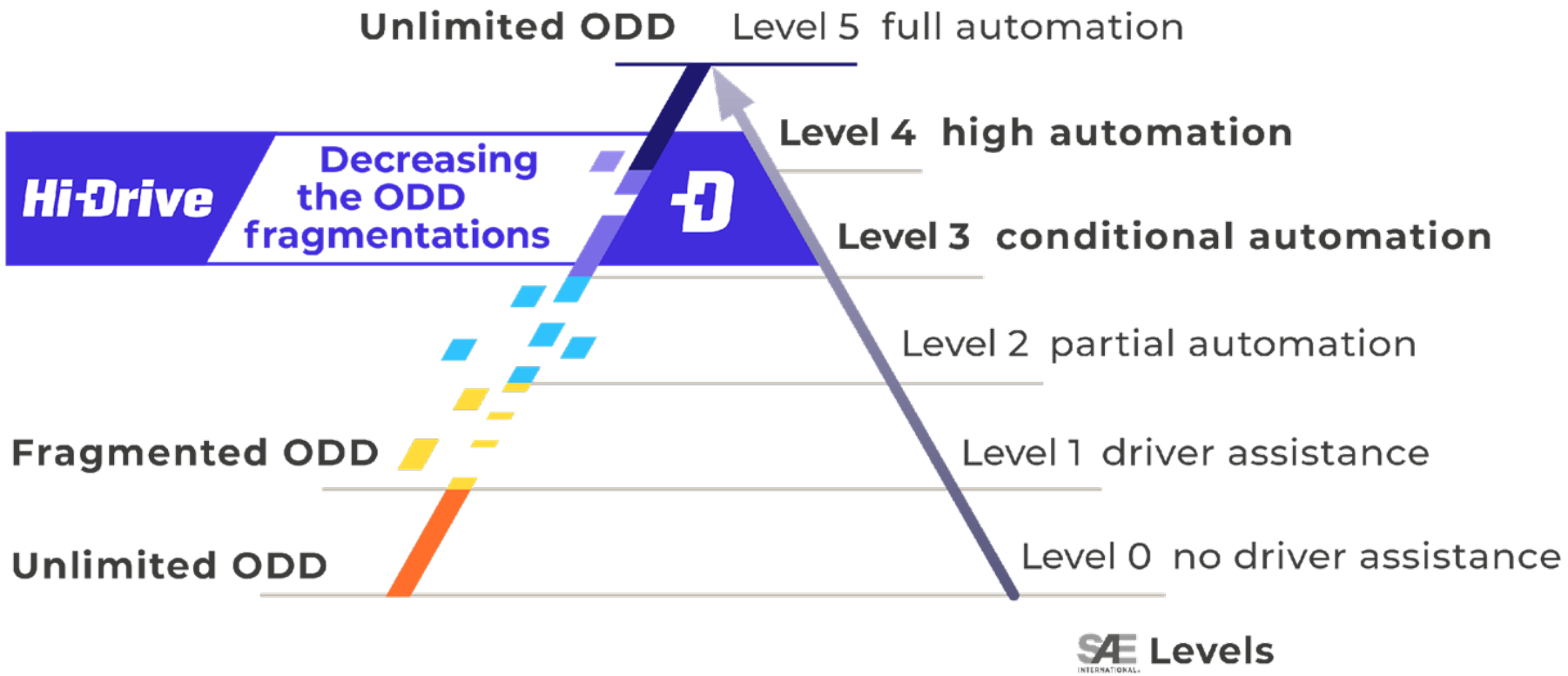
1. Hi Drive Use Case Description
2. Tunnel Rennsteig Information
3. Challenges
4. Valeo Motorway Chauffeur
5. Conclusion

Hi Drive

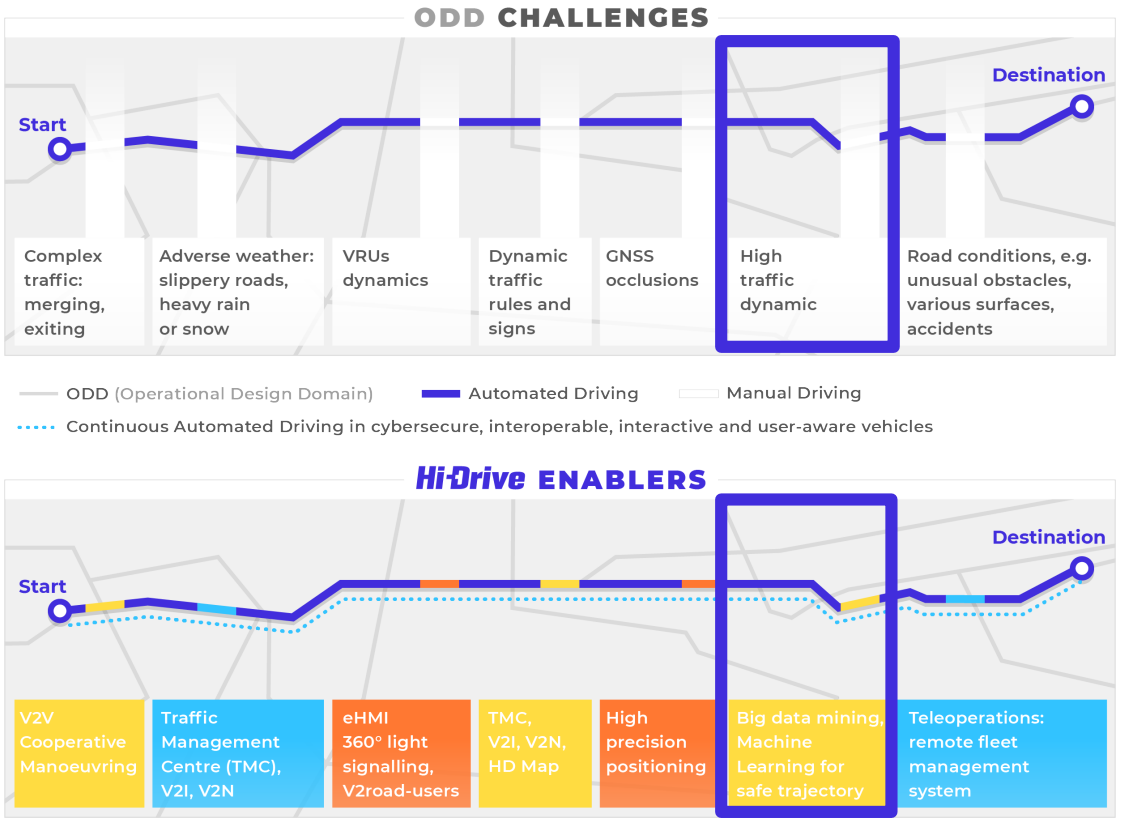
1

Hi Drive Use Case Description

Push Towards Higher Automation

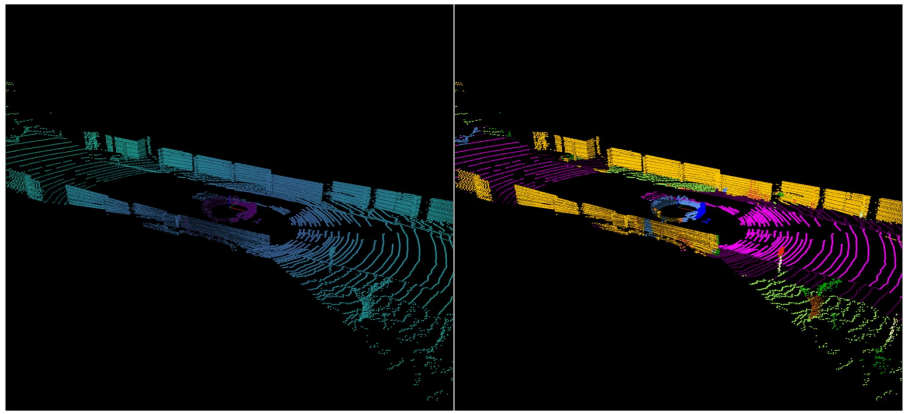


Defragmentation of the Operational Design Domain

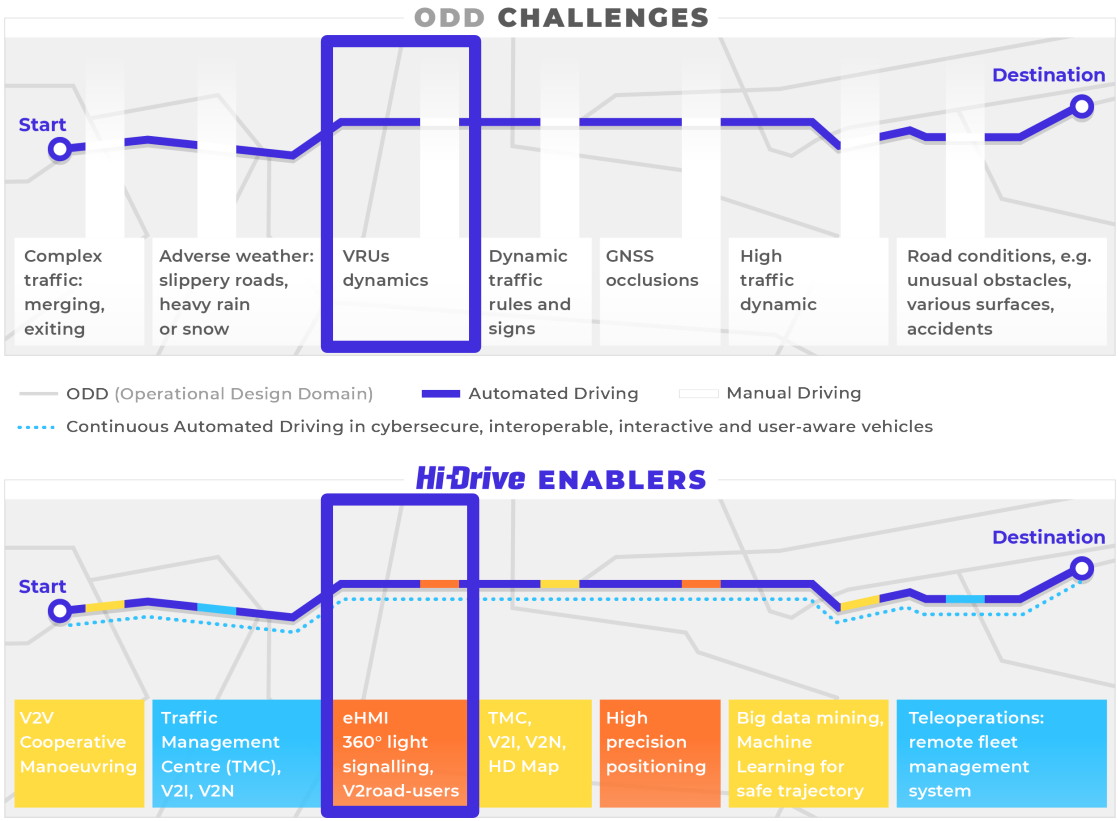


Valeo's Contribution in Machine Learning

Comprehensive perception for robust and safe navigation will be achieved through **Point cloud segmentation**.



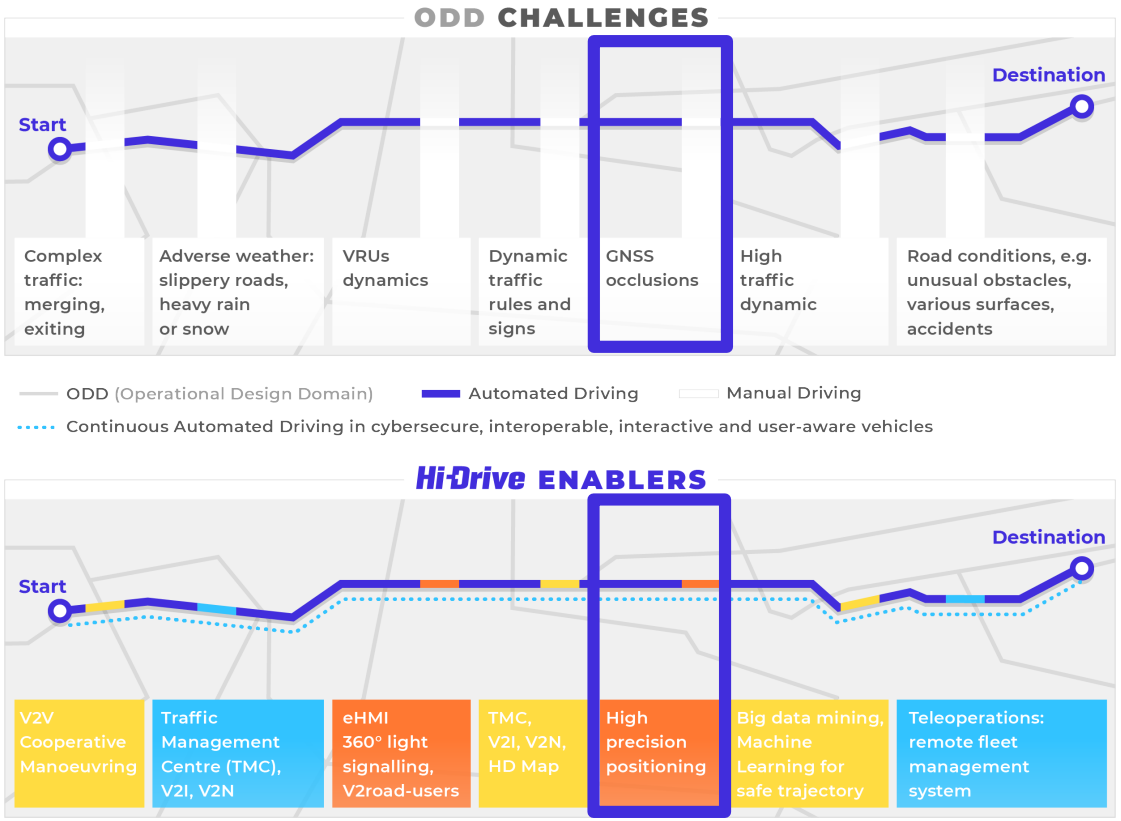
Defragmentation of the Operational Design Domain



Valeo's Contribution in Light Signalling

Communication and interaction with road users through lighting systems (Valeo VLS).

Defragmentation of the Operational Design Domain



Valeo's Contribution in Localization

Precise Vehicle Localization providing an accurate vehicle positioning system to eliminate GNSS blackspots

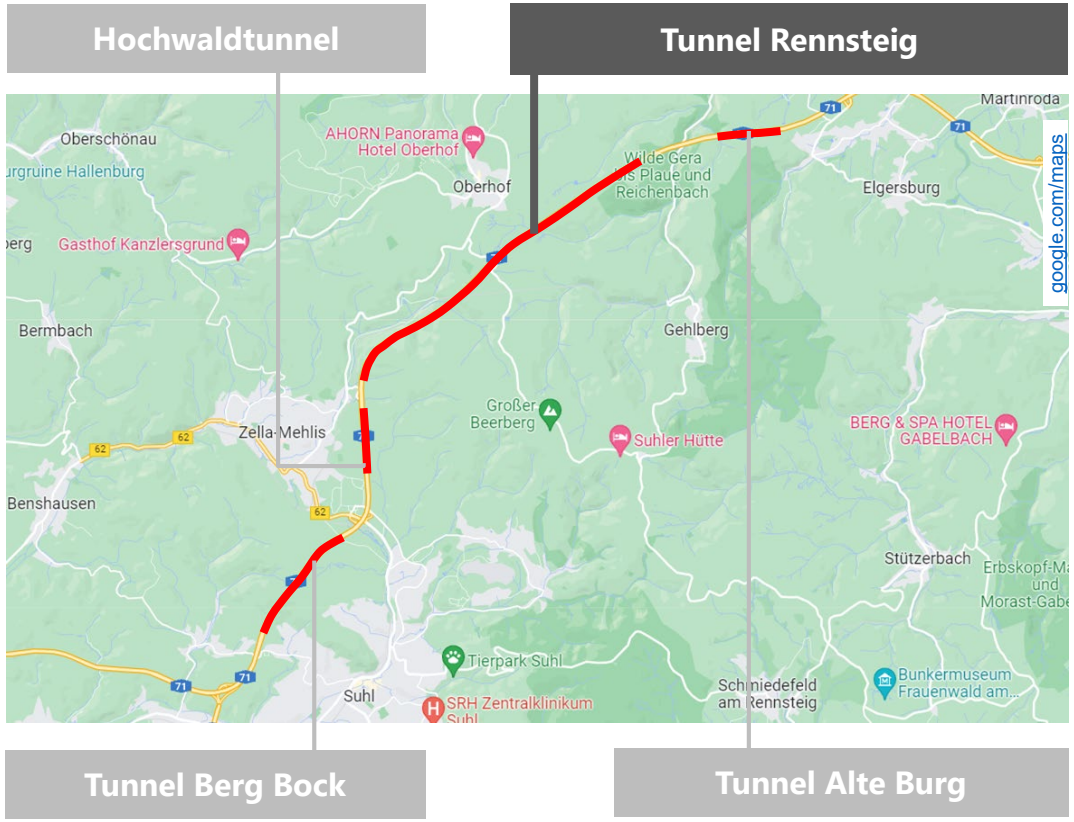
Hi-Drive

2

Tunnel Rennsteig Information

Location


Thuringia
71 Gräfenroda - Oberhof


Hochwaldtunnel
Tunnel Rennsteig
Oberschönau
AHORN Panorama Hotel Oberhof
Oberhof
Wilde Gera bis Plaue und Reichenbach
Elgersburg
Martinroda
Gasthof Kanzlersgrund
Bermbach
Gehlberg
Großer Beerberg
Suhler Hütte
BERG & SPA HOTEL GABELBACH
Zella-Mehlis
Benshausen
Stützerbach
Tierpark Suhl
Suhl
SRH Zentralklinikum Suhl
Schmiedefeld am Rennsteig
Bunkermuseum Frauenwald am...
google.com/maps
Tunnel Berg Bock
Tunnel Alte Burg

Key facts

7916 m
longest road tunnel in germany

9.5 m width
4.5 m height

200.000.000
construction costs

50 %
time saving [Suhl <-> Erfurt]

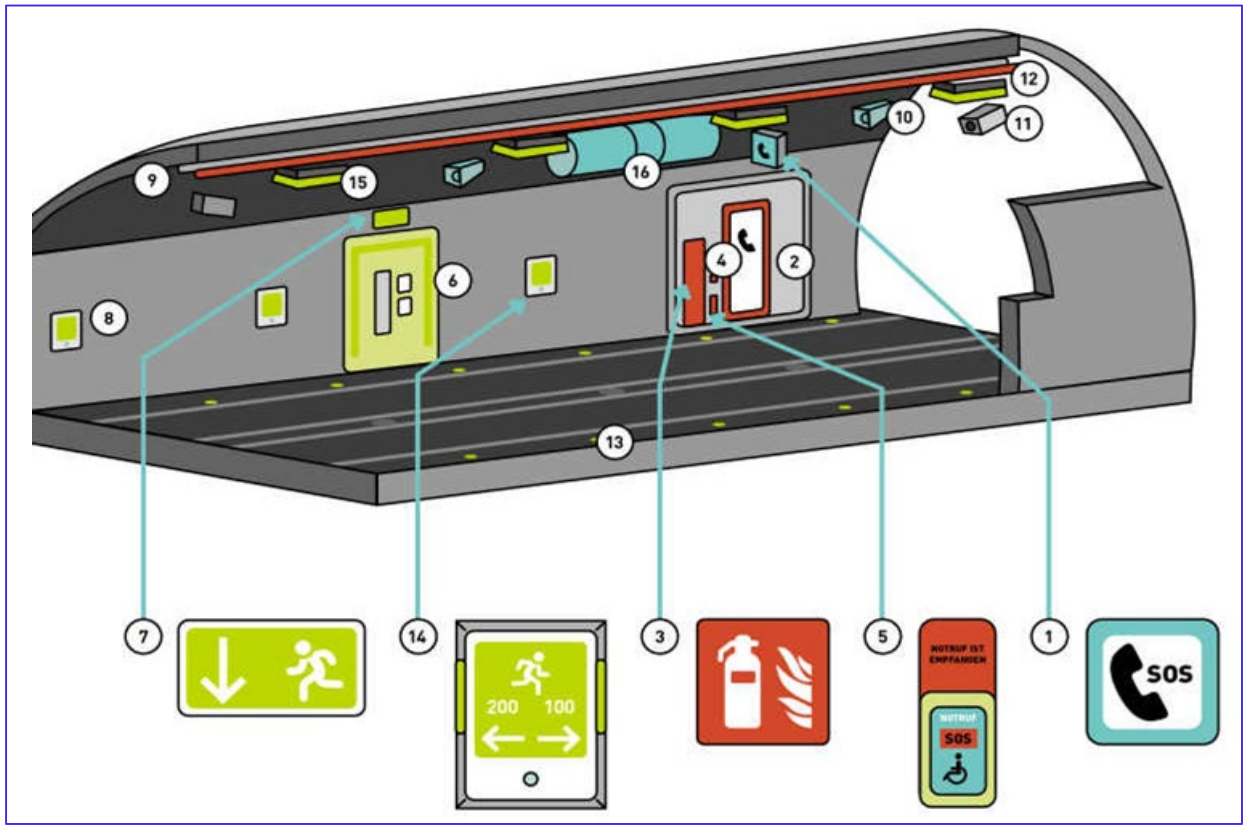
5 years
of construction (1998 - 2003)

1.350.000 m^3
excavated material

80
speed limit [km/h]

25
cross tunnels to escape

Safety facilities



1	signaling emergency call device
2	emergency call cabin
3	fire extinguisher
4	fire alarm
5	handicapped accessible call button
6/7	emergency exit
8	escape route sign
9	antenna cable for radio reception
10	speakers
11	video camera
12	fire detector
13	markings
14	orientation lighting in case of fire
15	illuminating device
16	venting system

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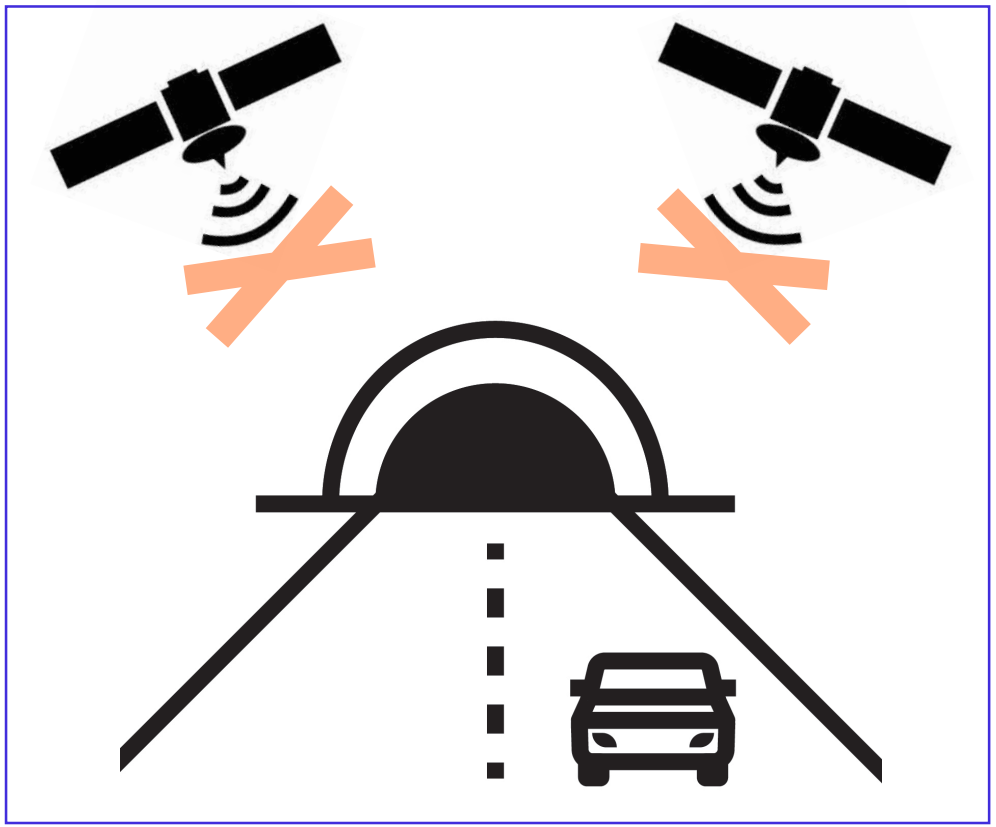
3

Challenges

Challenges related with tunnels



GNSS denied area

- Short interruptions
  e.g. occlusions from buildings and bridges
  Valeo's Drive4U system works
- Tunnel Rennsteig has >6 min. of **no GNSS signal**
- Navigation systems give up
- Limitations in position accuracy arise

Challenges related with tunnels

Poor camera view

- Due to artificial illumination, positioning by camera gets tricky

Challenges related with tunnels

Dark/Light Transition

- Sharp contrasting lighting
  when entering and exiting the tunnel

Challenges related with tunnels

Limited roadway width

- Restricted geometry:
  lateral deviations due to incorrect steering leads easily to collisions and increase the risk of accidents
- no emergency lane
- only a small pavement [width 0.25 meters (9.8 inch)]
- stopping is difficult and dangerous

Challenges related with tunnels

High risk - a history of devastating accidents:

Mont Blanc Tunnel 1999
39 deaths

Tauerntunnel 1999
12 deaths

Gletscherbahn Kaprun 2000
155 deaths

Gotthard-Tunnel 2001
11 deaths

https://www.mdr.de/nachrichten/thueringen/nord-thueringen/eichsfeld/unfall-sperrung-heidkopftunnel-verletzte-100.html

Challenges related with tunnels

Maneuvering in case of fire

- Main risk with using Automated cars in tunnels is that they may not operate in a safe manner in case of fire [1]

[1] https://www.loteconsulting.com/documents/Safety_Tunnels.pdf
Image:https://www.insuedthueringen.de/inhalt.auto-geraet-in-brand-rennsteig-tunnel-nach-unfall-gesperrt.454ed08f-adeb-46c2-b833-8c32fe24e11c.html

Challenges related with tunnels

Temperature gradient

- Windshield Fogging in road tunnels due to water condensation
- Also tricky for cameras!

Challenges related with tunnels

Non-standardized Tunnels

- Different infrastructure standards for different tunnels

Challenges related with tunnels

Different road surfaces (snow, rain)

https://www.google.com/url?sa=i&url=https%3A%2F%2Funsplash.com%2Fs%2Fphotos%2Fwet-road&psig=AOvVaw3_u5v9SCK6YT9U1nISms3k&ust=1683276254572000&source=images&cd=vfe&ved=0CBEQ3YkBahcKEwjwg_f3otv-AhUAAAAAHQAAAAAQEA

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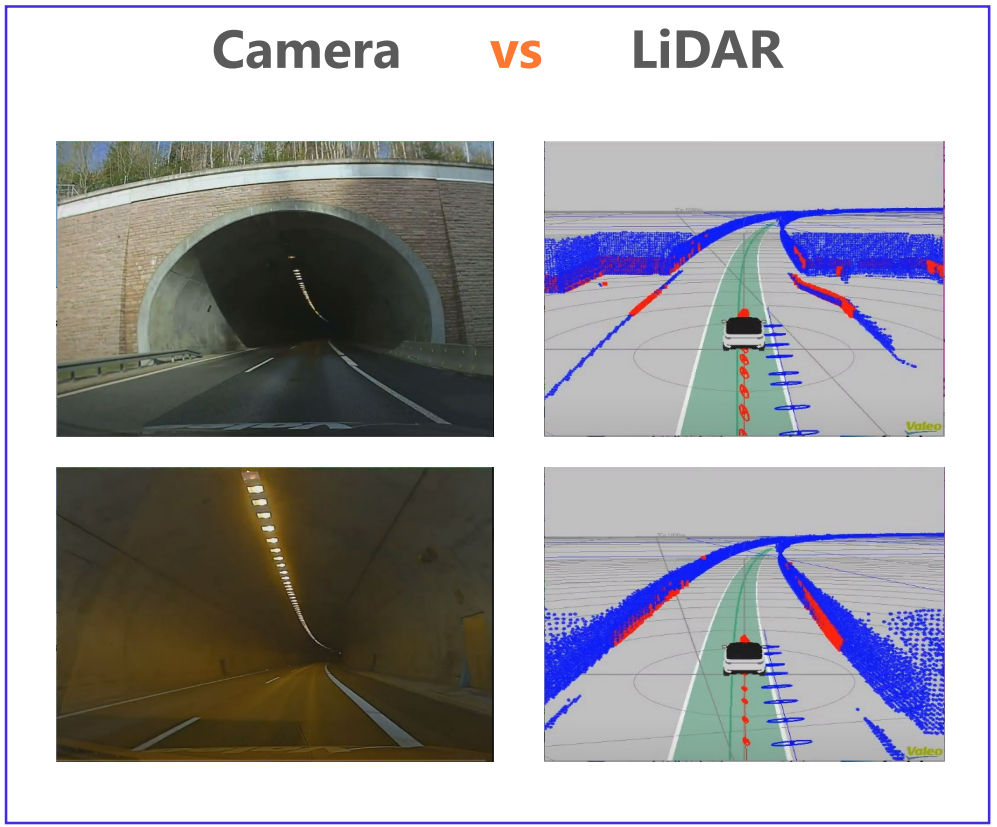
4

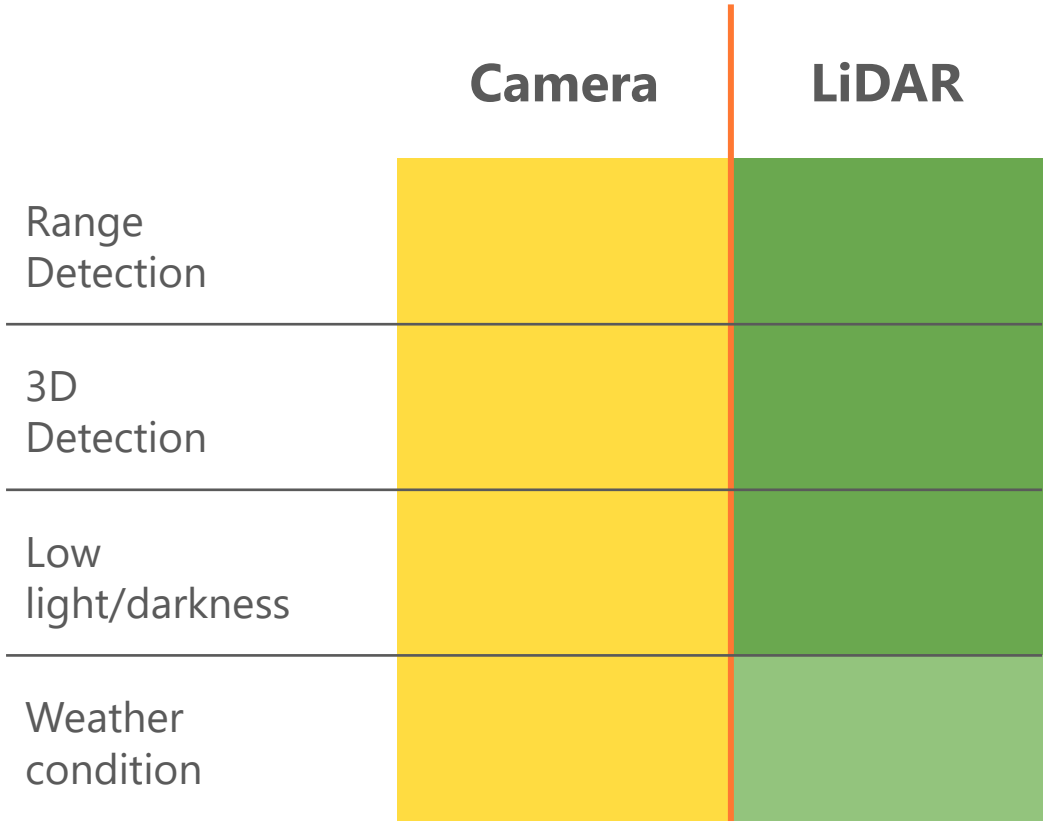
Valeo Motorway Chauffeur

Motorway Chauffeur

- ✓ Usable for all GNSS-denied areas
- ✓ Low ambient lighting conditions

Motorway Chauffeur

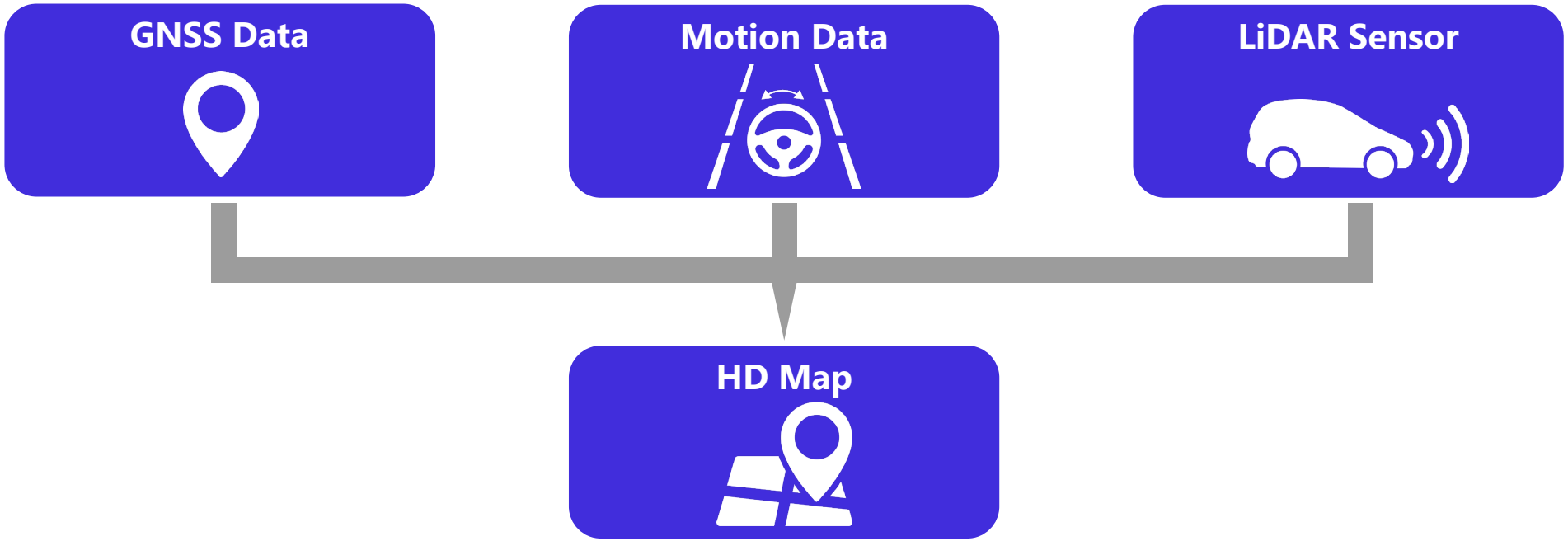




High precision positioning and localization

WP2.4 Enabler

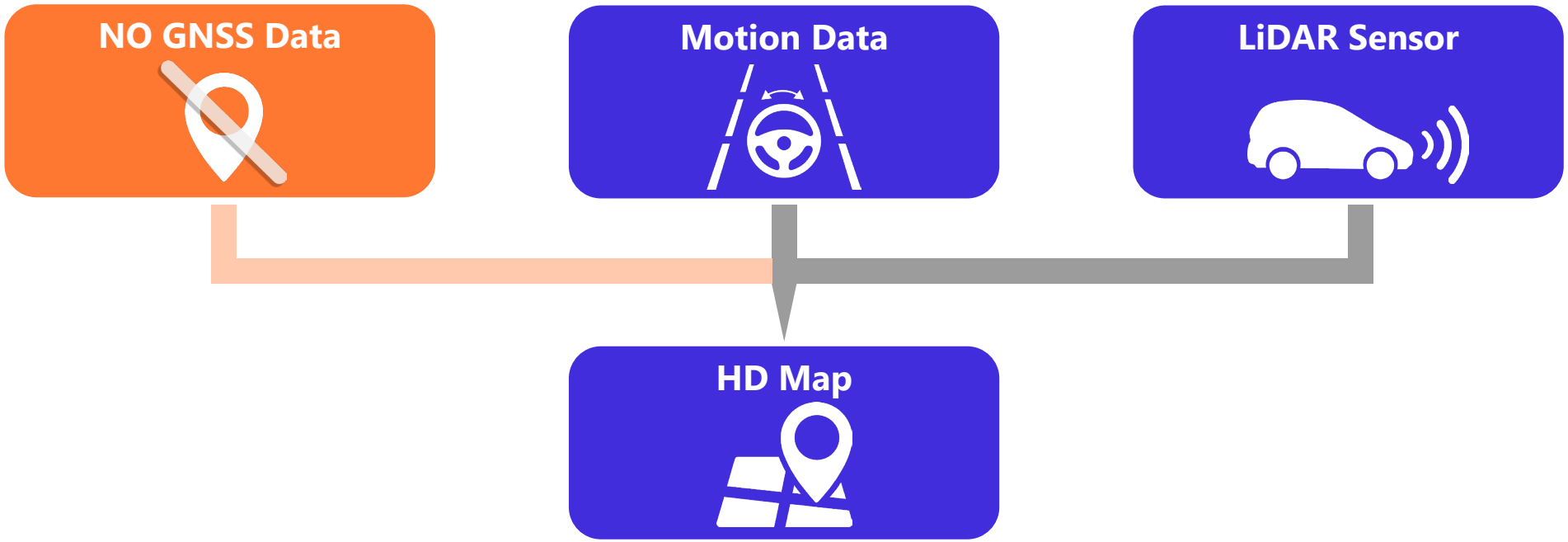
Mapping



High precision positioning and localization

WP2.4 Enabler

Mapping



High precision positioning and localization

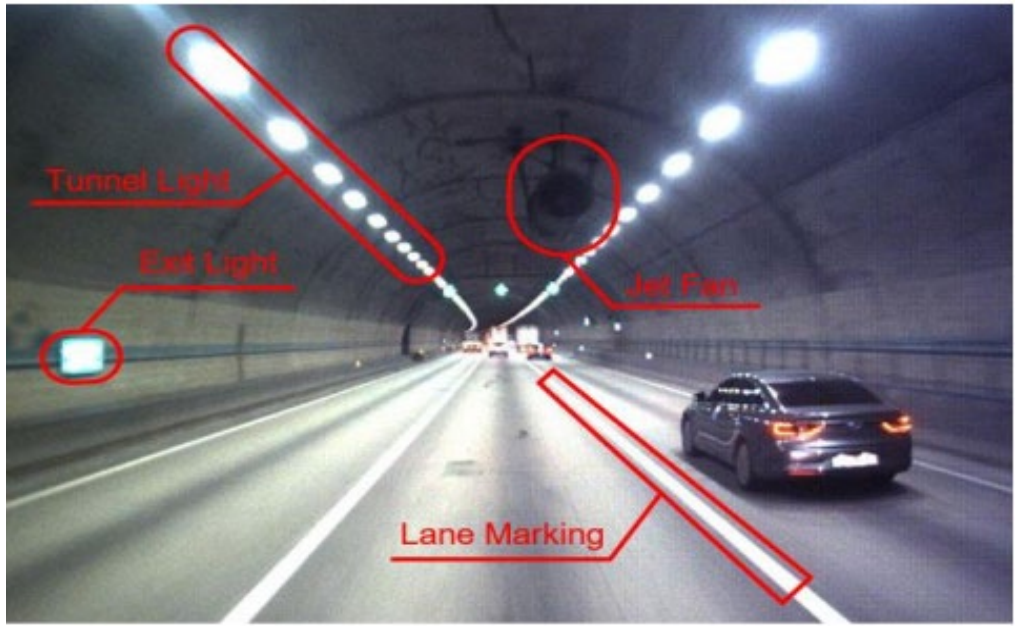
WP2.4 Enabler

Simultaneous Localization

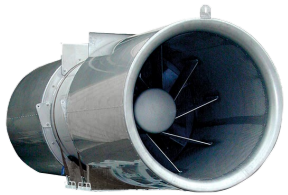
HD Map

Access and entrance
@Tunnel Rennsteig

Tunnel facilities used for map matching

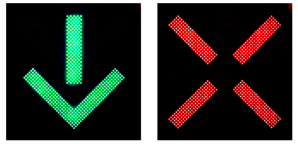


Exit sign



Jet fan

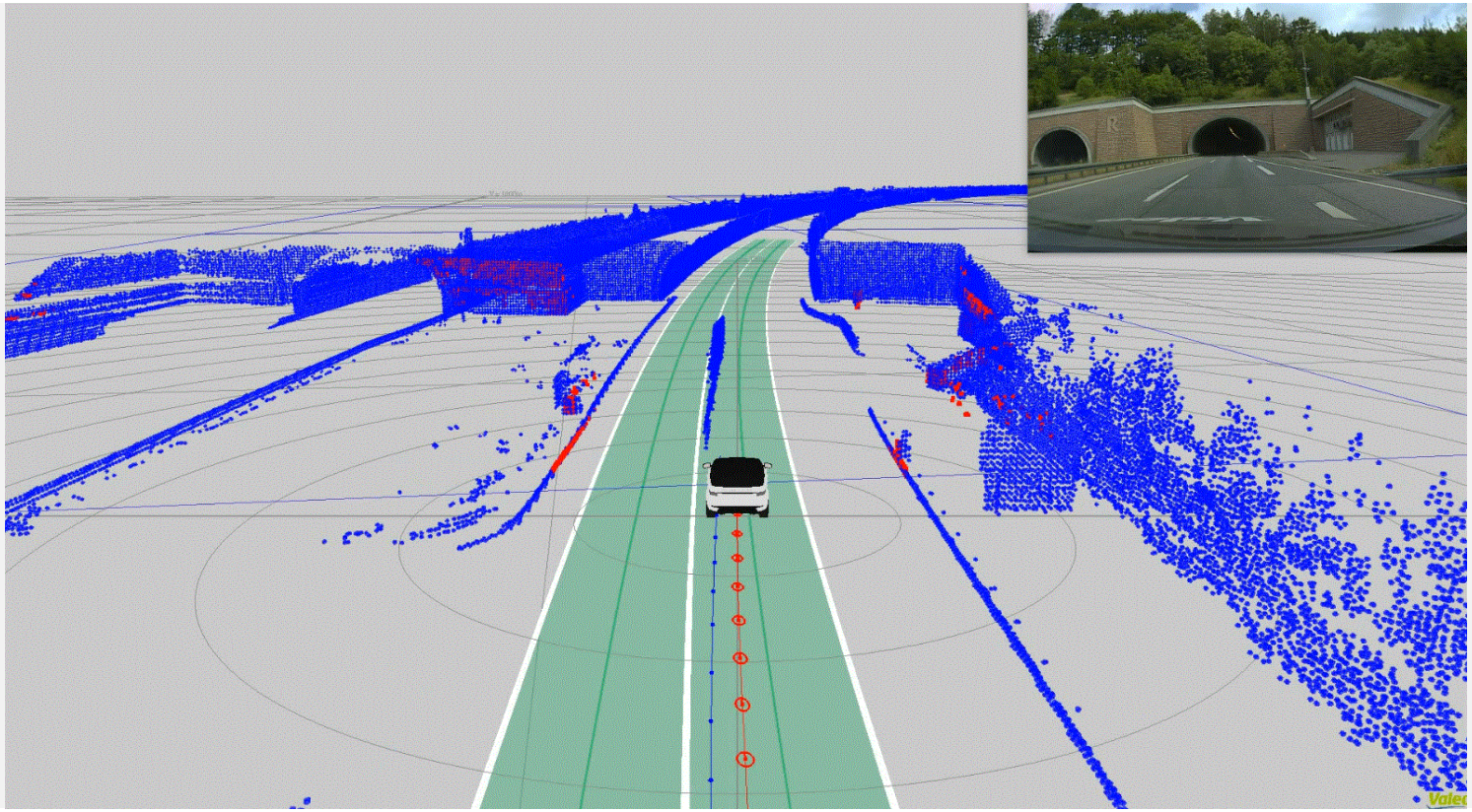
Tunnel lights



Lane control system (LCS)

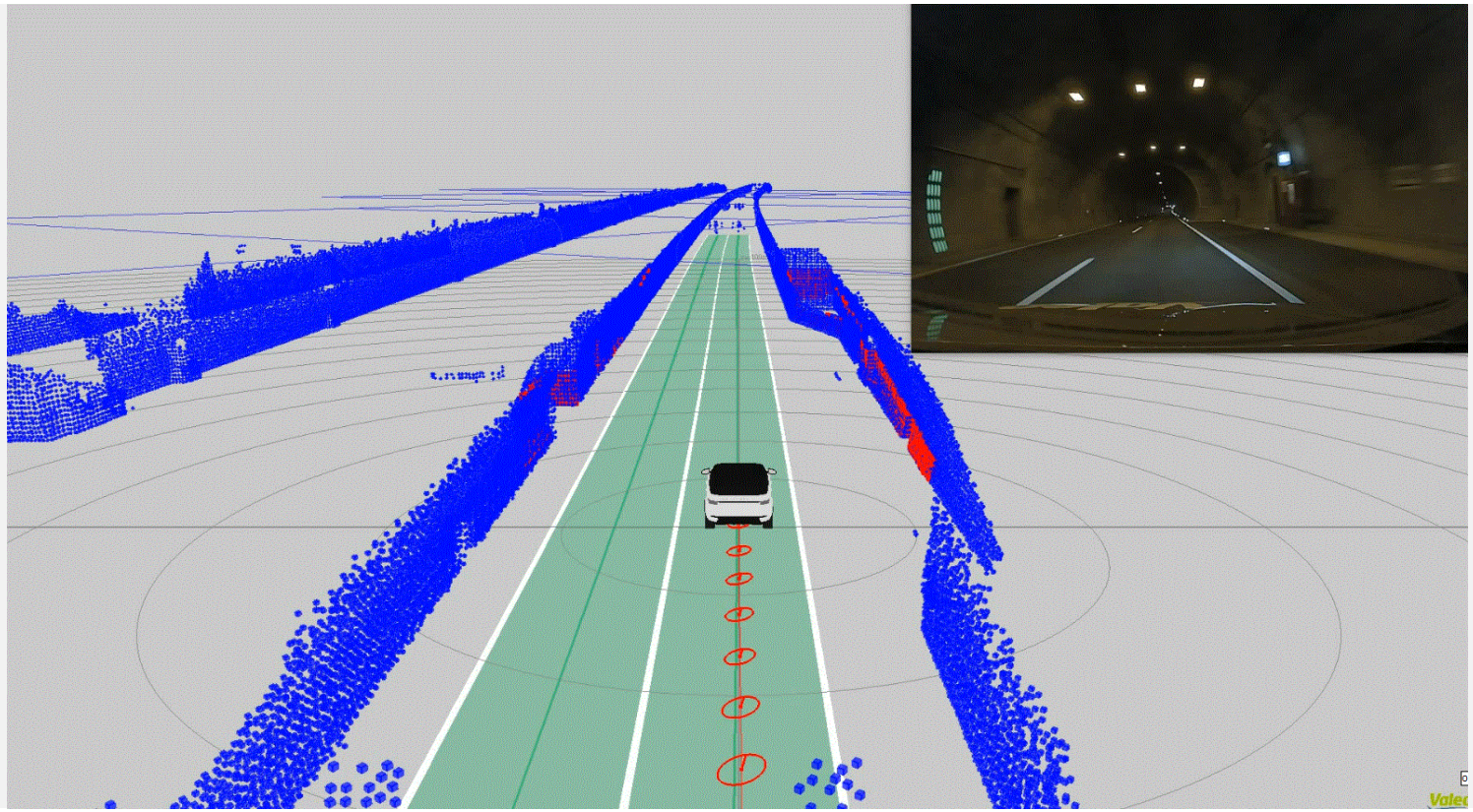
High precision positioning and localization

WP2.4 Enabler



High precision positioning and localization

WP2.4 Enabler



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5

Conclusions

Conclusion

- Tunnels pose a large variety of challenges compared to most other ODDs.
- Precise Localization and Positioning inside the tunnel is difficult due to repeating structures.
- Using LiDAR and Inertial Measurement Unit, it is possible to create a High Definition (HD) map of the tunnel.
- This HD map is then to carry out map matching thereby accurately positioning the vehicle inside the tunnel.
- Using the above developed enabler, the Valeo Motorway Chauffeur is able to successfully drive through the biggest tunnel in Germany in complete autonomous mode.


Wellness zu allen 4 Jahreszeiten
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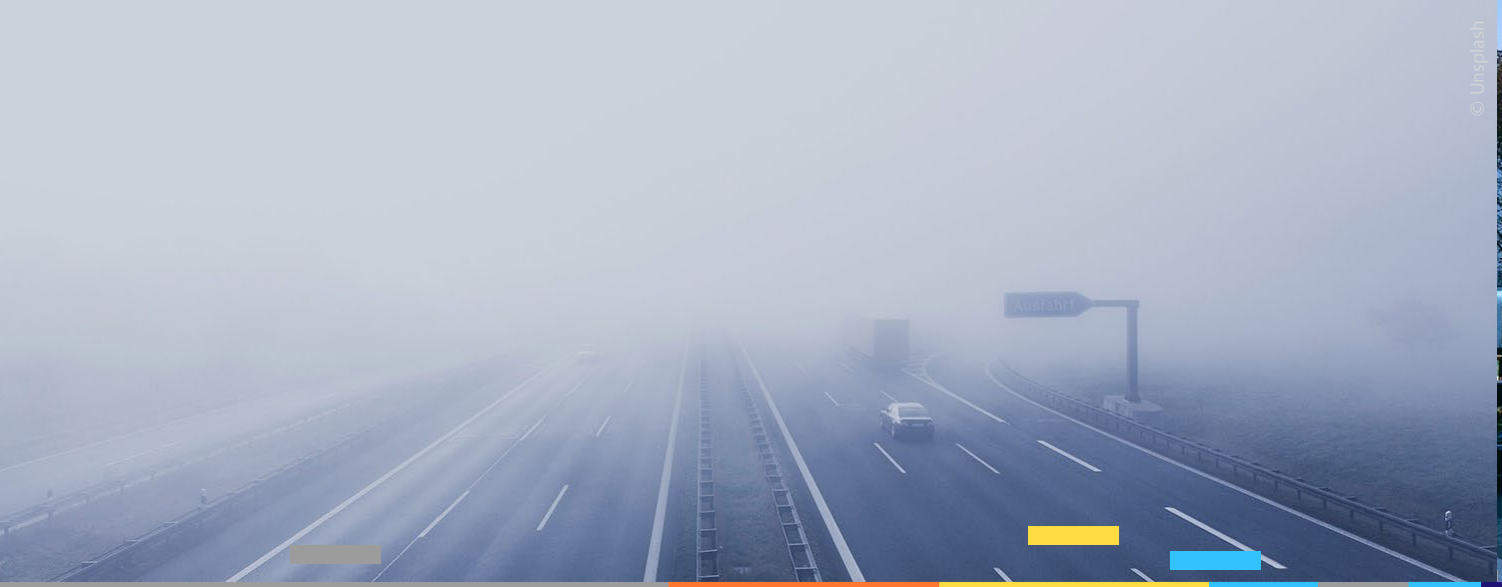
Hi Drive
LB VS 161



THANK YOU FOR YOUR KIND ATTENTION.

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