

Integration of vehicle and infrastructure systems

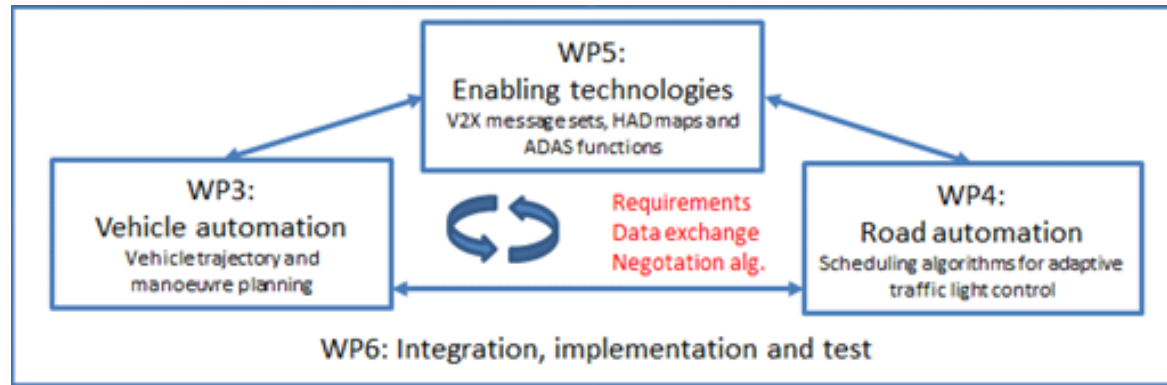
Julian Schindler
Lead researcher at DLR



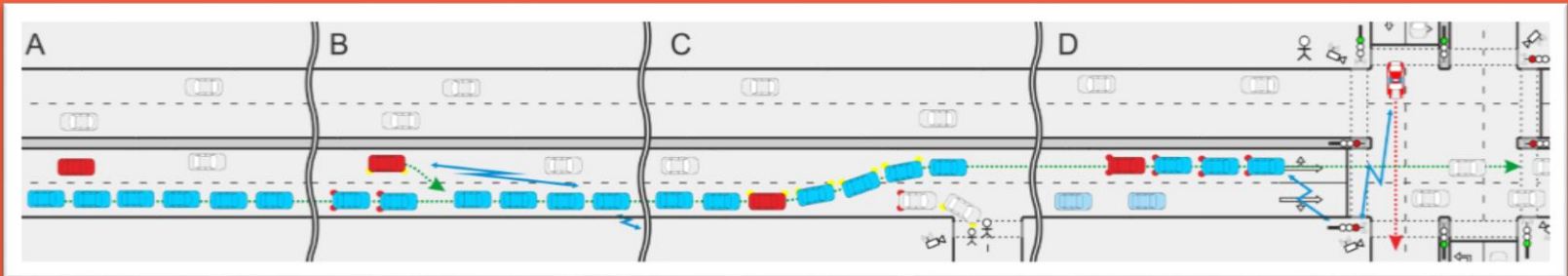
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Introduction



Integrated Prototype



Helmond

Braunschweig

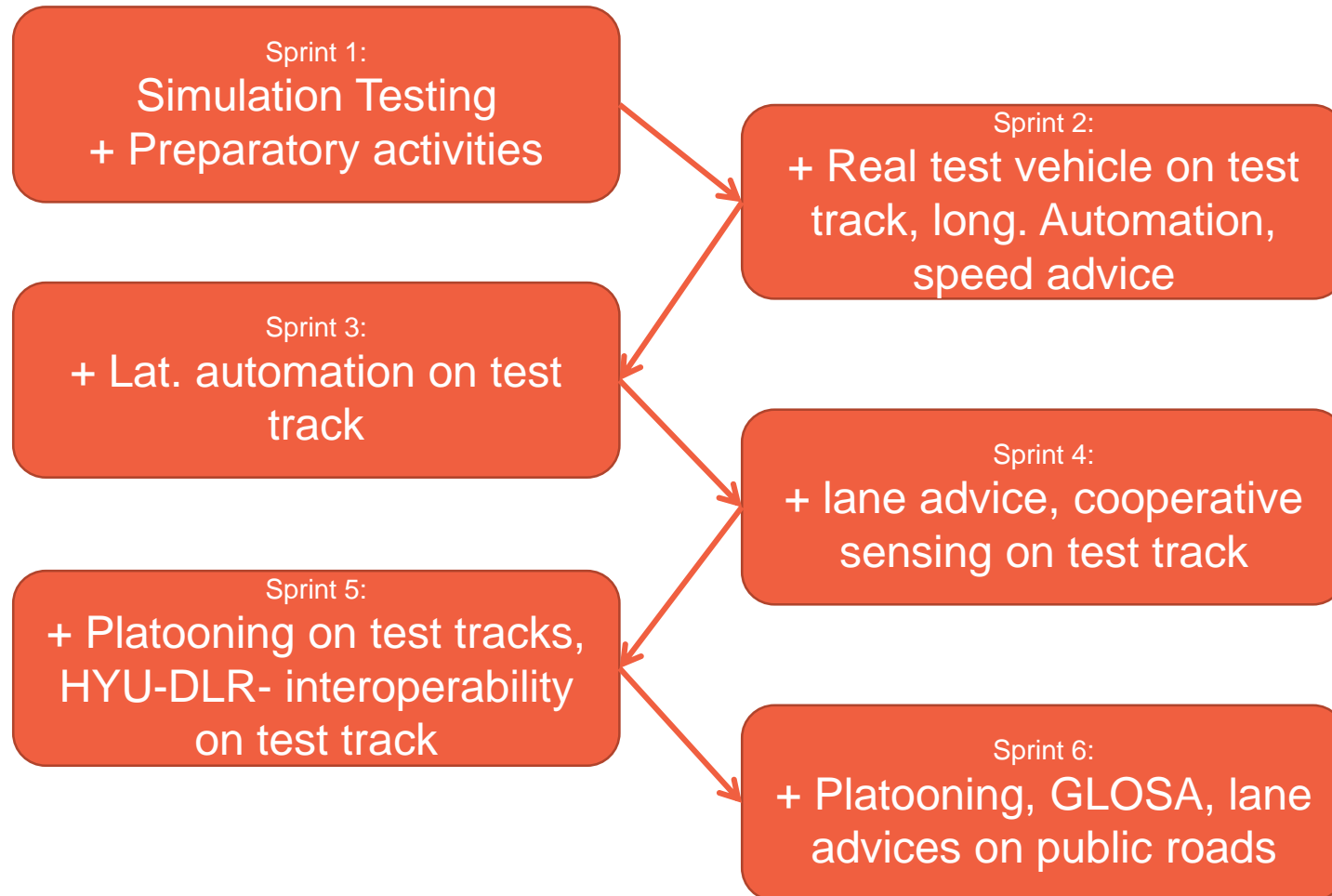
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Integration plan



Sprint 1:
Simulation Testing
+ Preparatory activities

Simulation Testing of GLOSA



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Sprint 1:
Simulation Testing
+ Preparatory activities

Vehicle setup

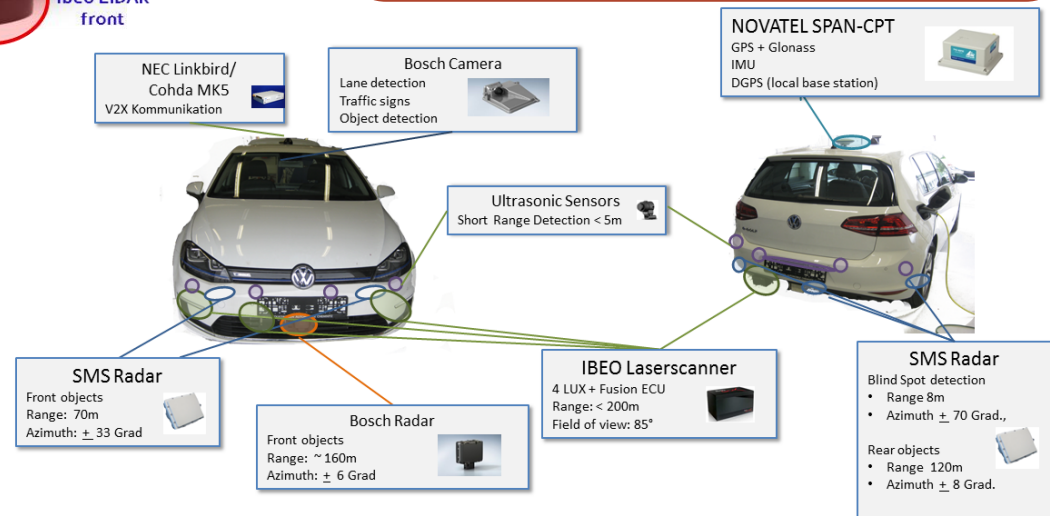


HMETC:
Setup of new Hyundai Ioniq

DLR:
Use of existing automated
vehicles FASCarE and
ViewCar2



ViewCar2



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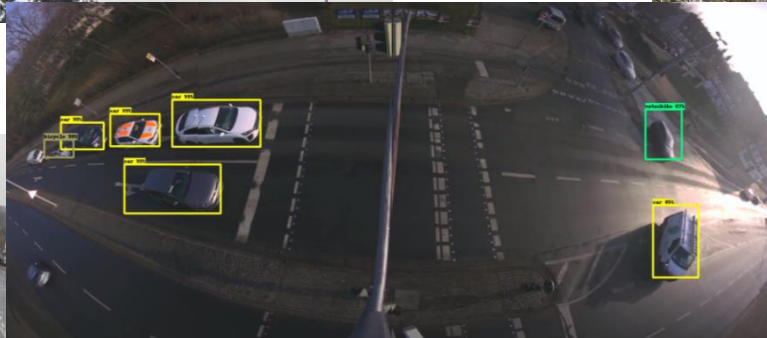


Sprint 1:
Simulation Testing
+ Preparatory activities

Infrastructure setup



Helmond



Braunschweig Tostmannplatz
(part of AIM reference track)



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Test track preparation



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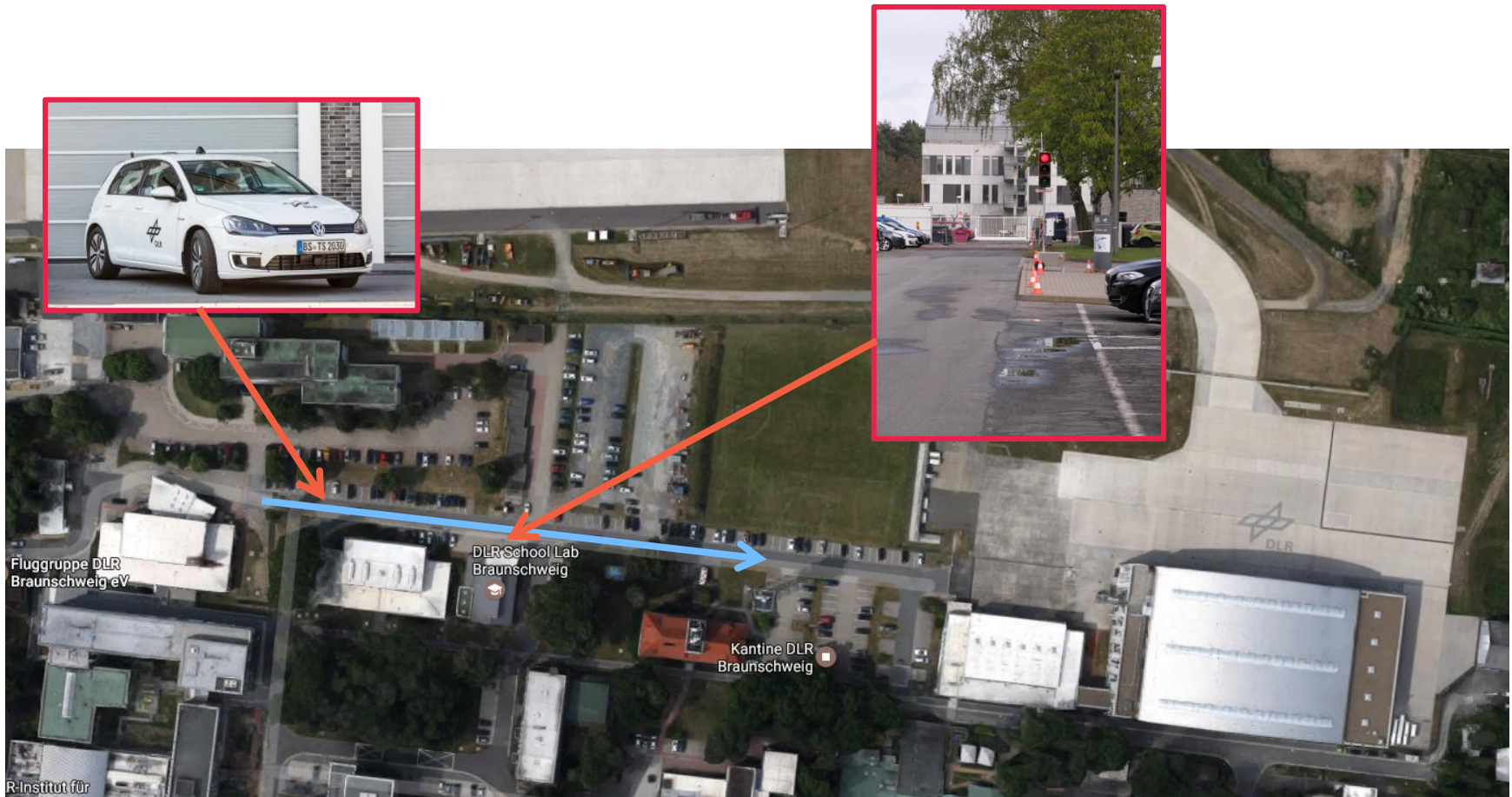
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Sprint 2:

+ Real test vehicle on test track,
long. Automation, speed advice

First GLOSA testing on test track



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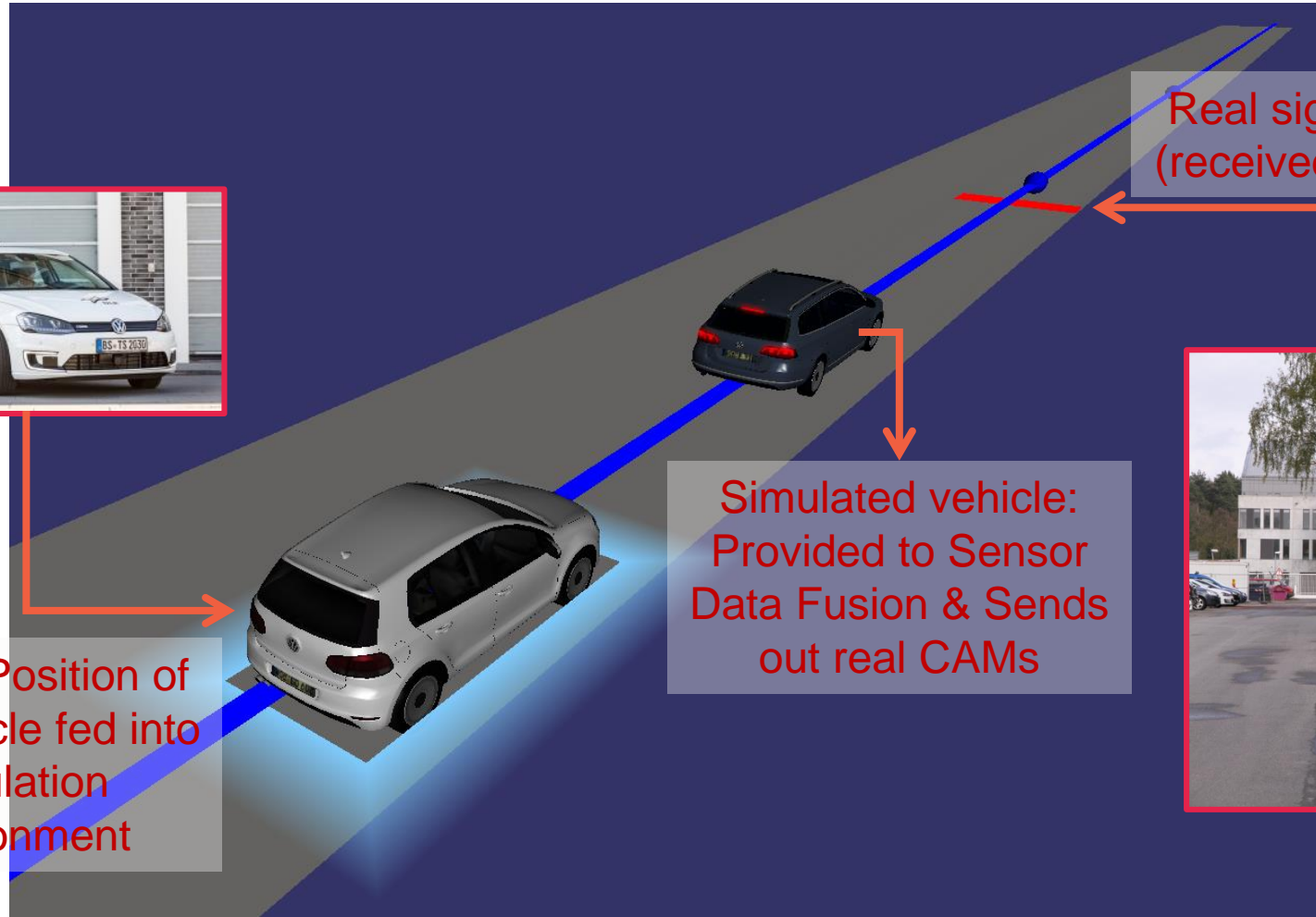
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Sprint 2:

+ Real test vehicle on test track,
long. Automation, speed advice

Emulation



Real signal phase
(received by SPAT)

Simulated vehicle:
Provided to Sensor
Data Fusion & Sends
out real CAMs

D-GPS Position of
real vehicle fed into
simulation
environment



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Sprint 3:
+ Lat. automation on test track

GLOSA with lat./long. automation

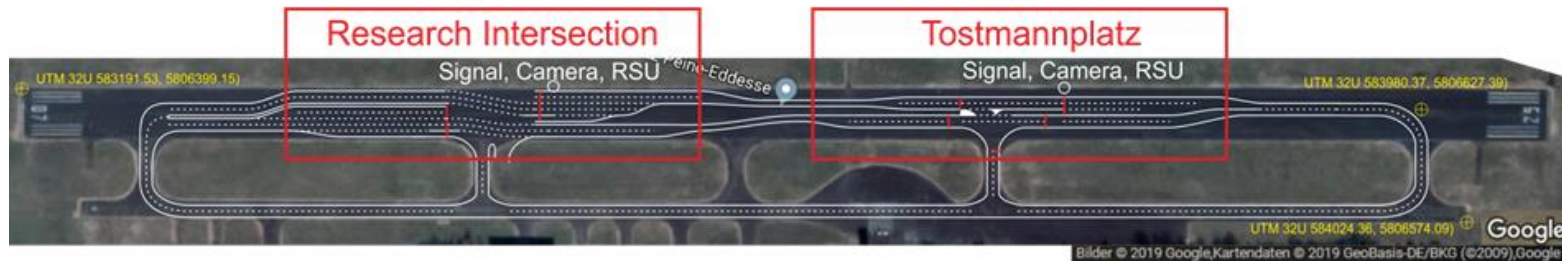


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Sprint 3:
+ Lat. automation on test track

Virtual test tracks

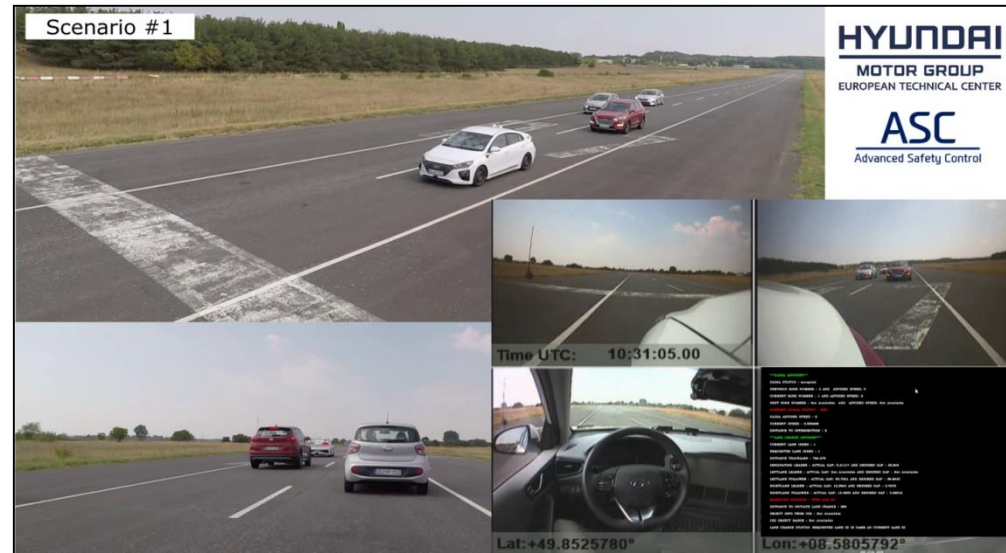
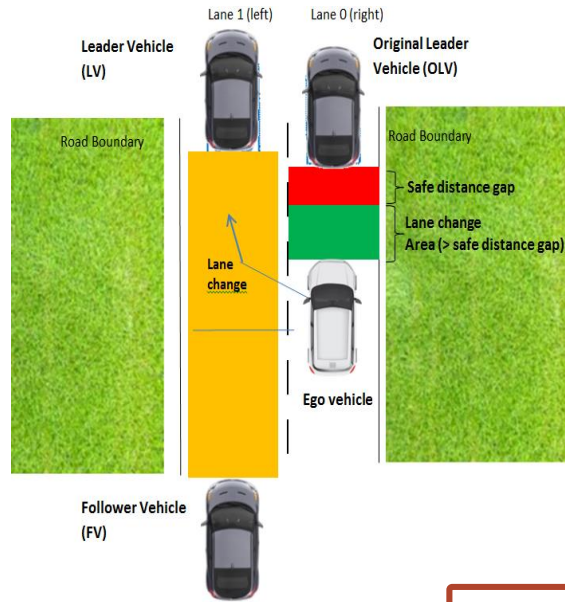


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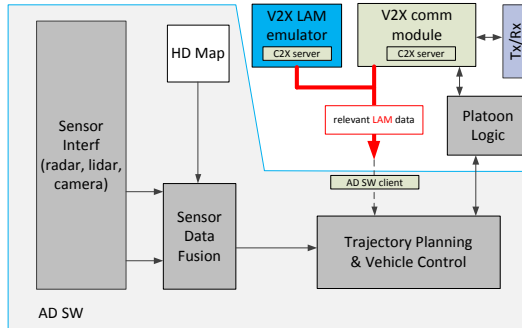
Sprint 3: + Lat. automation on test track

Lane Advices

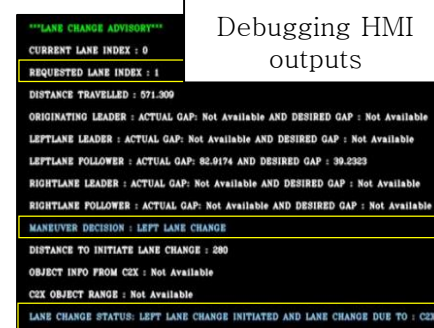


LAM implementation and emulation tests

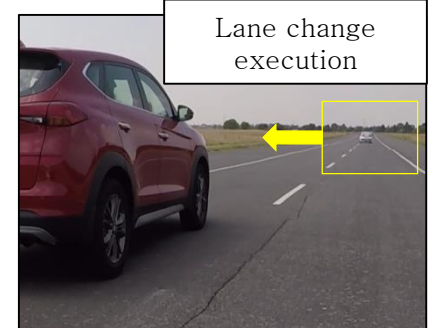
Implementation



Testing



Lane change execution



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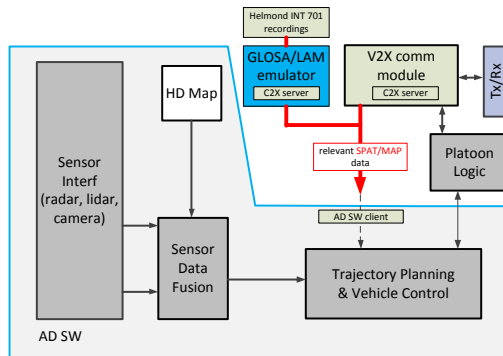


Sprint 4:
+ lane advice, cooperative
sensing on test track

Combined Speed and Lane Advices

Implementation/testing of Helmond GLOSA, also combined with LAM (UC7 and UC8)

Implementation



Replay of Helmond INT 701 GLOSA at HMETC AD car on Griesheim track:
Speed-zones dynamically change (move twds stop line) according to current
time/phase



Debugging HMI outputs (GLOSA – Helmond 701)

```
***GLOSA ADVISORY***
GLOSA STATUS : Accepted
PREVIOUS ZONE NUMBER : Not Available AND ADVISED SPEED : Not Available
CURRENT ZONE NUMBER : 3 AND ADVISED SPEED : 39.96
NEXT ZONE NUMBER : 2 AND ADVISED SPEED : 34.92
CURRENT SIGNAL STATUS : RED
GLOSA ADVISED SPEED : 39.96
CURRENT SPEED : 48.6325
DISTANCE TO INTERSECTION : 319
```

Debugging HMI outputs (GLOSA + LAM)

```
***GLOSA ADVISORY***
GLOSA STATUS : REJECTED AND REASON IS : PRESENCE OF OBSTACLE
PREVIOUS ZONE NUMBER : 1 AND ADVISED SPEED : 29.96
CURRENT ZONE NUMBER : 0 AND ADVISED SPEED : 0
NEXT ZONE NUMBER : Not Available AND ADVISED SPEED : Not Available
CURRENT SIGNAL STATUS : RED
GLOSA ADVISED SPEED : 0
CURRENT SPEED : 49.6344
DISTANCE TO INTERSECTION : 243

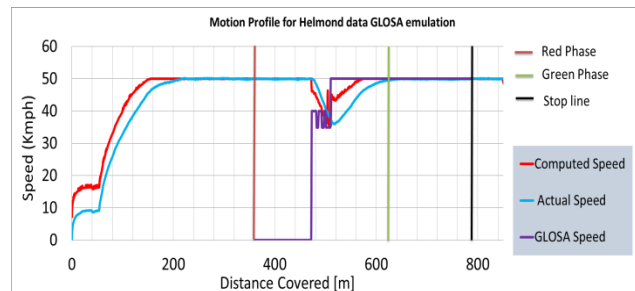
***LANE CHANGE ADVISORY***
CURRENT LANE INDEX : 0
REQUESTED LANE INDEX : 1
DISTANCE TRAVELLED : 563.6
ORIGINATING LEADER : ACTUAL GAP : 84.3096 AND DESIRED GAP : 57.2224
LEFTLANE LEADER : ACTUAL GAP : 63.8109 AND DESIRED GAP : 24.6434
LEFTLANE FOLLOWER : ACTUAL GAP : Not Available AND DESIRED GAP : Not Available
RIGHTLANE LEADER : ACTUAL GAP : Not Available AND DESIRED GAP : Not Available
RIGHTLANE FOLLOWER : ACTUAL GAP : Not Available AND DESIRED GAP : Not Available
DISTANCE TO INITIATE LANE CHANGE : 250
LANE CHANGE STATUS : LEFT LANE CHANGE INITIATED AND LANE CHANGE DUE TO : C2X
```

Testing

Lane change execution



GLOSA speed adaptation



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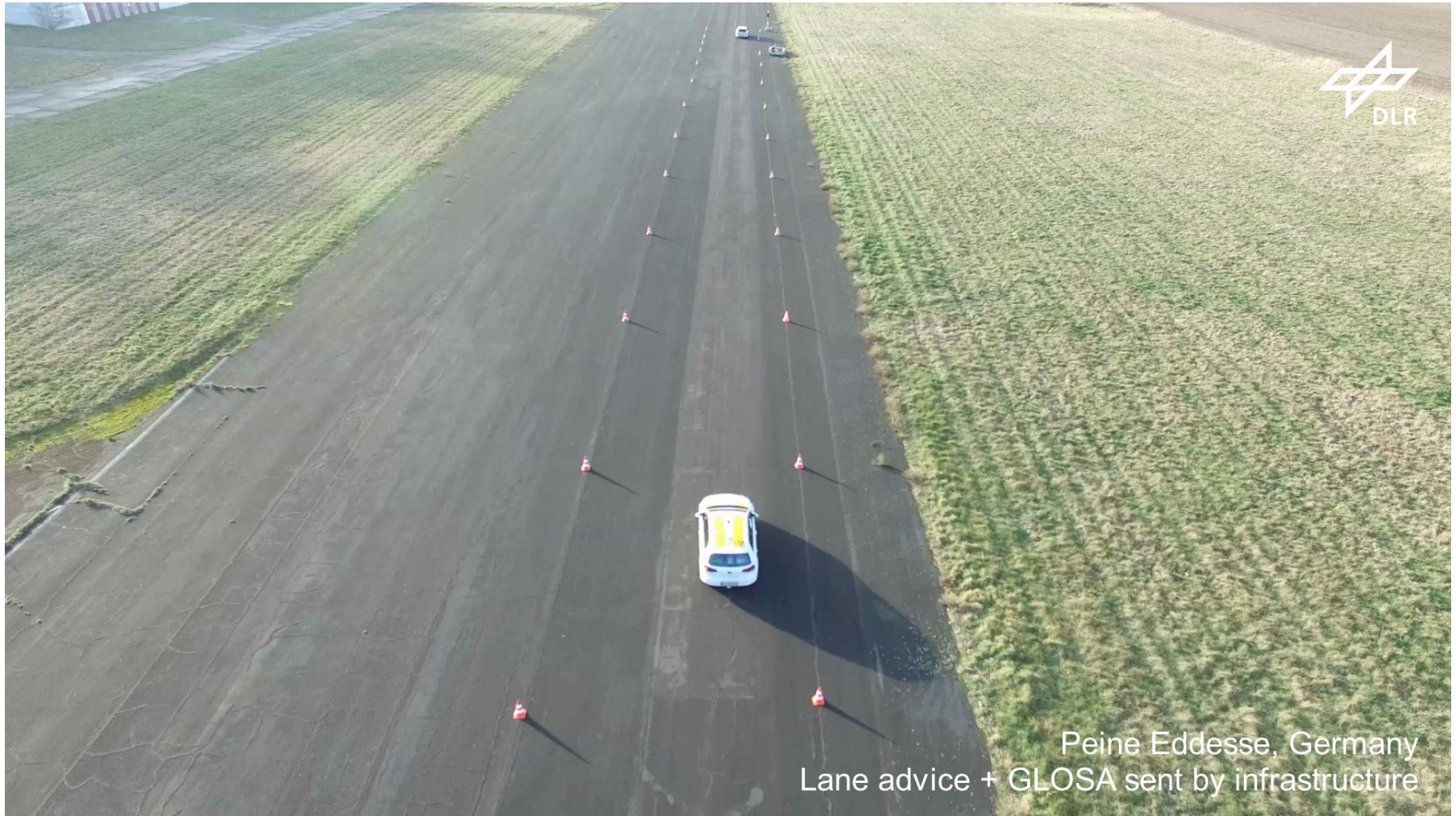


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Sprint 4:
+ lane advice, cooperative
sensing on test track

Combined Speed and Lane Advices



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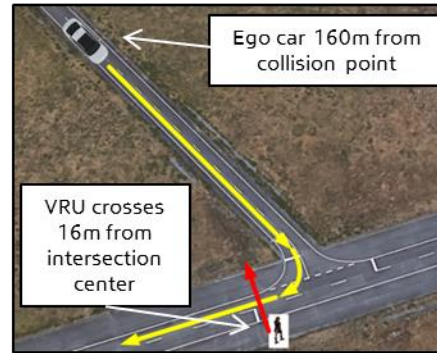
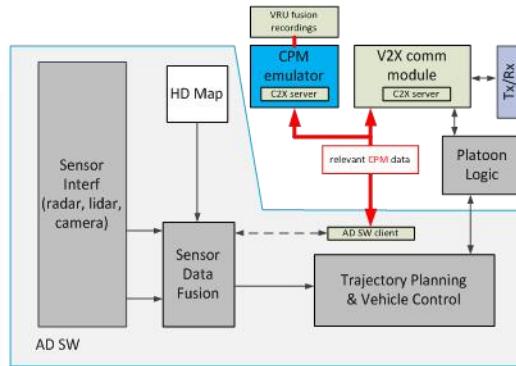


Sprint 4:
+ lane advice, cooperative
sensing on test track

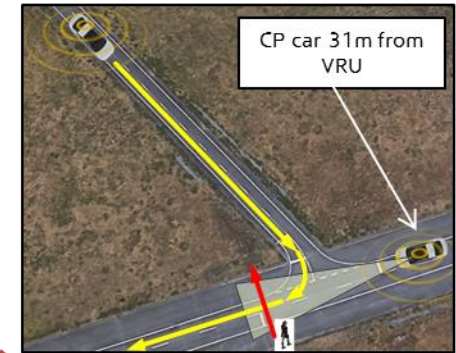
Cooperative Sensing: CPM Testing

Implementation/testing of cooperative sensing ADAS based on V2V (UC16)

Implementation

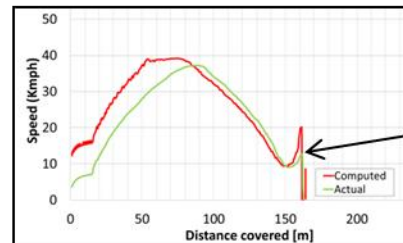
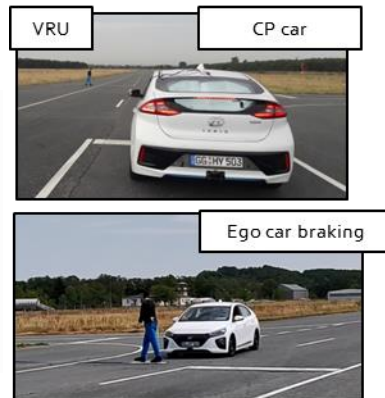


Scenario 1: ego car without CP, only ego sensors used

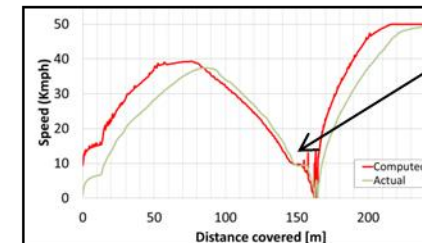


Scenario 2: ego car also considers V2X info by replaying receptions from CP car

Testing



Scenario 1: ego car speeds up while turning and does not detect VRU in time → manual braking to avoid collision



Scenario 2: ego car knows about VRU (via V2X), smoothly slows down while turning, detects VRU in time → automated braking, collision is prevented; speeds up again after VRUs crosses



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Sprint 5:
+ Platooning on test tracks, HYU-
DLR- interoperability on test track

Combined Platooning with GLOSA



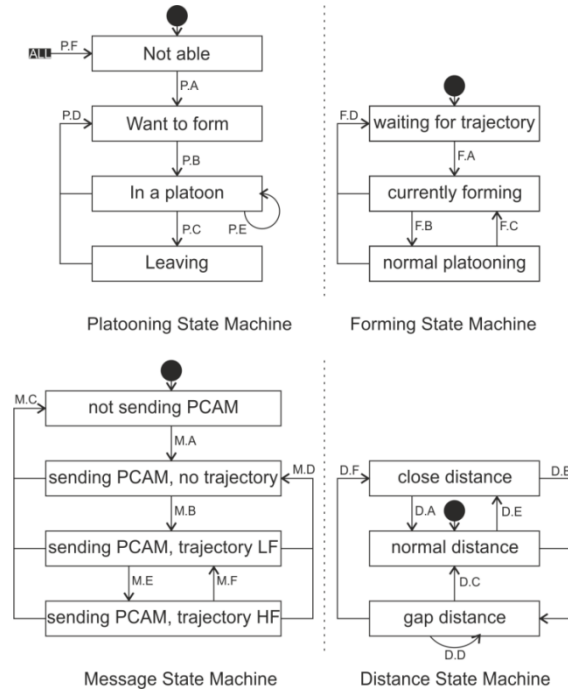
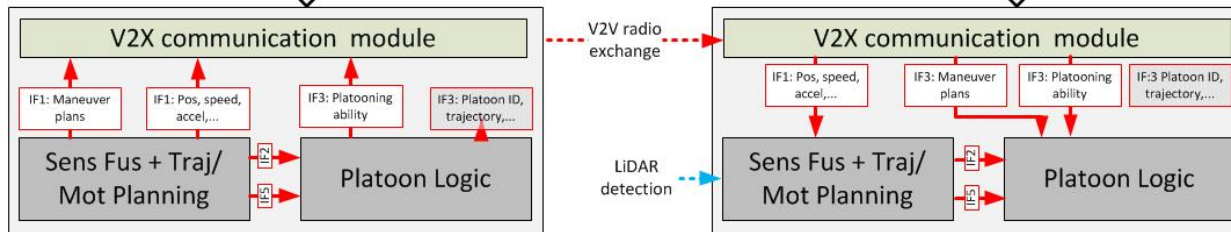
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Sprint 5:

+ Platooning on test tracks, HYU-DLR- interoperability on test track

Platoon Interoperability Testing



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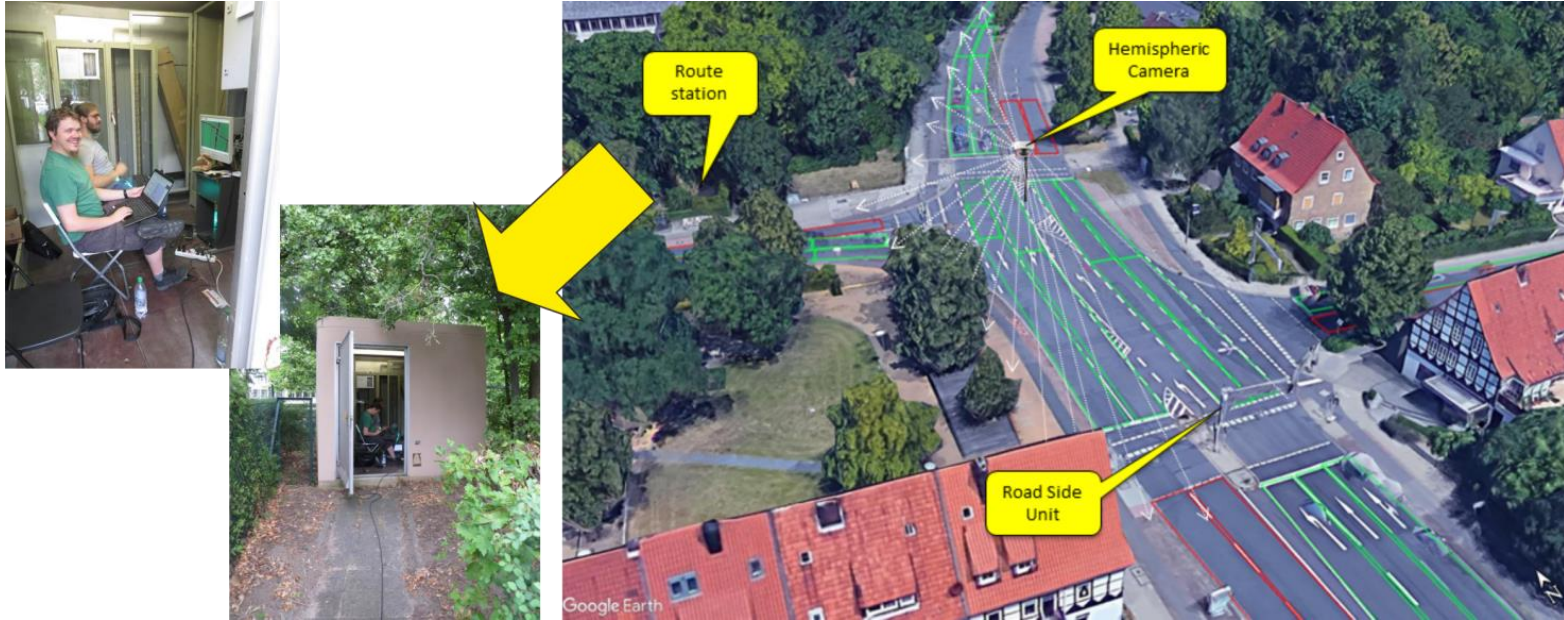


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Sprint 5:
+ Platooning on test tracks, HYU-
DLR- interoperability on test track

Preparation for final tests on public roads



- Sending of SPaT/MAP/CPM messages
- Integration of AGLOSA on Tostmannplatz
- Several tests on public roads with passive vehicle automation



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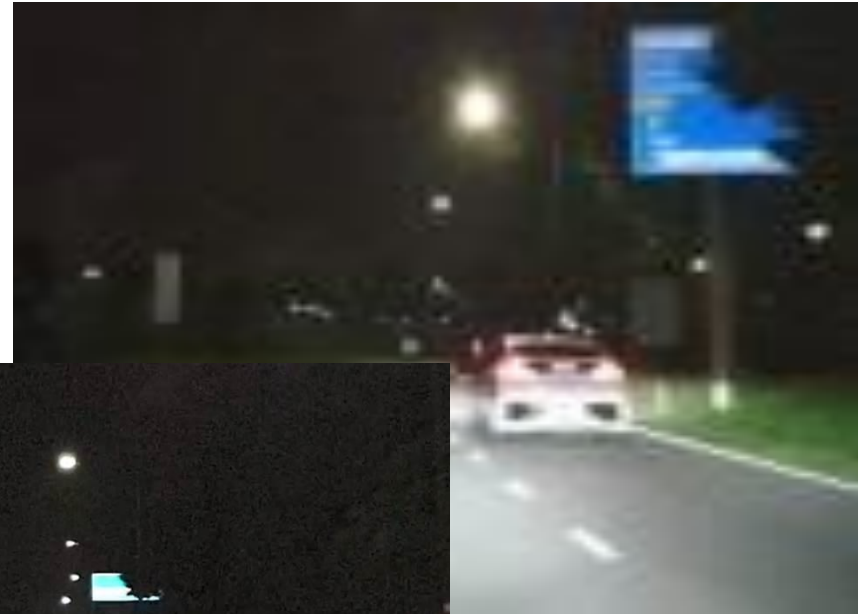


Sprint 6:
+ Platooning, GLOSA and lane
advices on public roads

GLOSA and Speed Advices in Helmond

Automation started,
indicated direction (go straight) to upcoming
traffic light

GLOSA and LAM received.
Adapting to advices



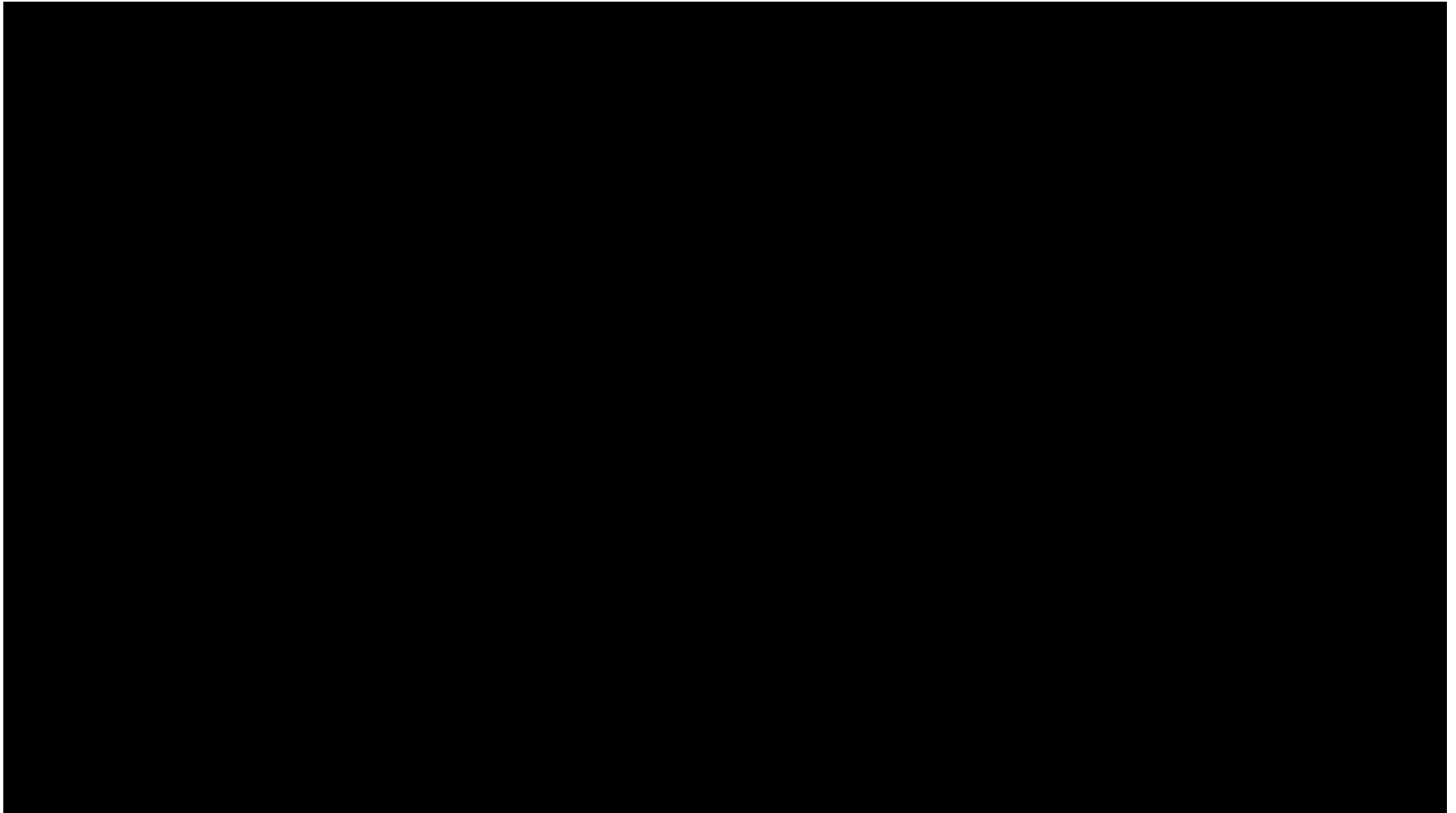
Reply with compliance to the advices.
Pass at green on desired lane

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Sprint 6:
+ Platooning, GLOSA and lane
advices on public roads

Platooning in Braunschweig



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Thank you!

Questions?



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