Implementation and Testing of Dynamic and Flexible Platoons in Urban Areas

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MAVEN

European H2020 project
- Period: 01-09-2016 ~ 31-08-2019
- Budget: € 3.149.661,-

Assumption:
- Road infrastructure applications will still play a key role in future cooperative automated driving era

Main objective
- Increasing traffic efficiency and safety in urban areas by exploiting automated driving

Approach
- C-ITS infrastructure-based traffic management solutions for cooperative automated vehicles (CAVs) at signalized intersections (traffic lights) and intersection corridors
- V2X-based automated driving extensions for perception and planning
- Use of simulation verification as well as road experiments with CAV and infra prototypes (ETSI ITS G5-based)
Use cases overview

- **I2V interactions**
  - V2I “explicit” probing + I2V speed/lane advisory + V2I feedbacks on compliance to advisories

- **Traffic controllers optimization**
  - Signal optimization, priority management, queue estimation, green wave

- **Platoon management**
  - Forming, joining, travelling in, leaving, breaking a platoon

- **Inclusion of conventional traffic and VRUs**
  - Detection/reaction in presence of non-coop cars & VRUs

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Highway Platooning vs. Urban Platooning

Main focus:
• Reduced fuel consumption

But:
• Simple situations
• Rel. high speeds

Main focus:
• High throughput on intersections

But:
• Complex situations
• High flexibility needed

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Urban Platooning: Approach

- **Flexibility in focus:**
  - Vehicles can join/leave at any time
  - Distances are set individually by the following vehicle
    - As done in Cooperative ACC
  - Each vehicle is the leader of its followers
  - Each leader communicates with the infrastructure

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**Communication**

**V2X Communication**
- Standard CAM with extension on **standard** channel

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<thead>
<tr>
<th>Ext CAM on SCH0</th>
<th>CoopAwareness</th>
<th>CAMParameters</th>
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<td>ItsPduHeader (as in [2])</td>
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- For everybody (including other vehicles, infrastructure)
- Route on upcoming intersection
- ... 
- List of platoon members

**V2V Communication**
- Standard CAM with extension on **extra** channel

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- For platoon members (esp. Followers)
- Extra
- States of platoon logic
- ... 

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Vehicle automation architecture (DLR & Hyundai)

- Partner-specific implementation of “core” AD SW modules
  - DLR: Dominion-based, Hyundai: ROS-based
- Common implementation of C2X functionalities
  - Same message set and interfacing with AD modules
- Common implementation of Platoon logic
  - Provided DLR as a library integrated in decision making modules

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Platoon forming, driving, break up

- **Based on state machine rules:**
  - If two or more vehicles detect having same features (speed/acceleration ranges) & objectives (route at next intersection)
  - If no obstacle in between (e.g. Non-cooperative vehicle)

- **Respects a predefined time headway:**
  - When a cooperative and automated vehicle is detected, a time headway-velocity profile is generated and kept as below figure.
  - For forming desired time headway is 2s and for break up is 4.
HiL testing of communication

• Verification of cooperative functionality at partner-specific implementation
• Separate tests @ DLR and Hyundai with simulated cars & real communication HW

HiL test of Platoon Logic using two Cohda MK5 units:

(A) RSU for the platoon leader
(B) OBU for the follower.

(The functionality of RSU and OBU is equal in this test.)

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Test track testing of platoon forming/driving

- Verification of cooperative functionality with combined implementationa
  - Joint real tests with real DLR and Hyundai cars & real communication HW

![Diagram showing V2V communication and Lidar integration in platoon forming/driving tests with DLR and HMETC cars.]

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Test track testing of Platooning + GLOSA (DLR)
Augmented Reality Testing: Using real-road GLOSA on test track

- Recording of SPAT/MAP + GLOSA traces at Tostmann platz
- Replaying of SPAT/MAP + GLOSA traces on Griesheim test track
  - Verifying AD speed adaptation to GLOSA speed

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Test track testing of real-road GLOSA (HMETC)
Augmented Reality Testing: Using quasi-real road layouts on test track
Augmented Reality Testing: Interacting with virtual vehicles

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Augmented Environment Architecture

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Extension 2: Platooning with 2 real cars

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Tostmannplatz public road testing

Hyundai and DLR cars

AVEN HMI on DLR car

GLOSA adaptation on Hyundai car

WORK IN PROGRESS!!!

Some platoon initialization instances, but functionality to be tested more extensively for consistency!!!
Additional information can be found at: 

www.maven-its.eu

Do not hesitate to contact us!

Thank you!

Questions?

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