



Infrastructure-Supported Cooperative Automated Driving in Transition Areas



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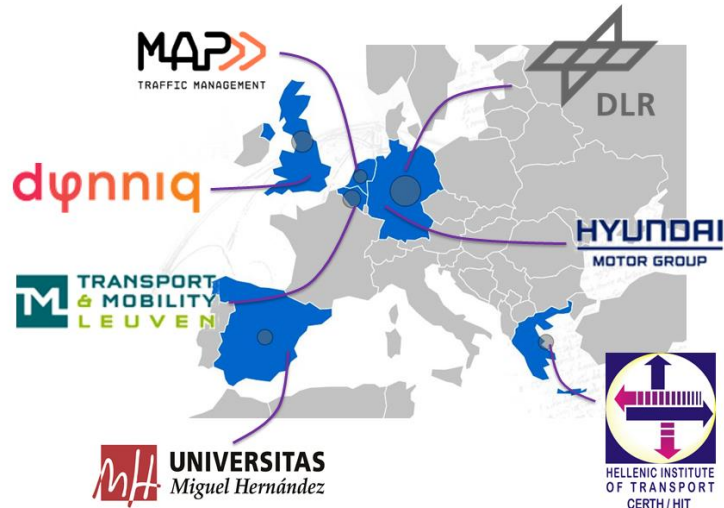
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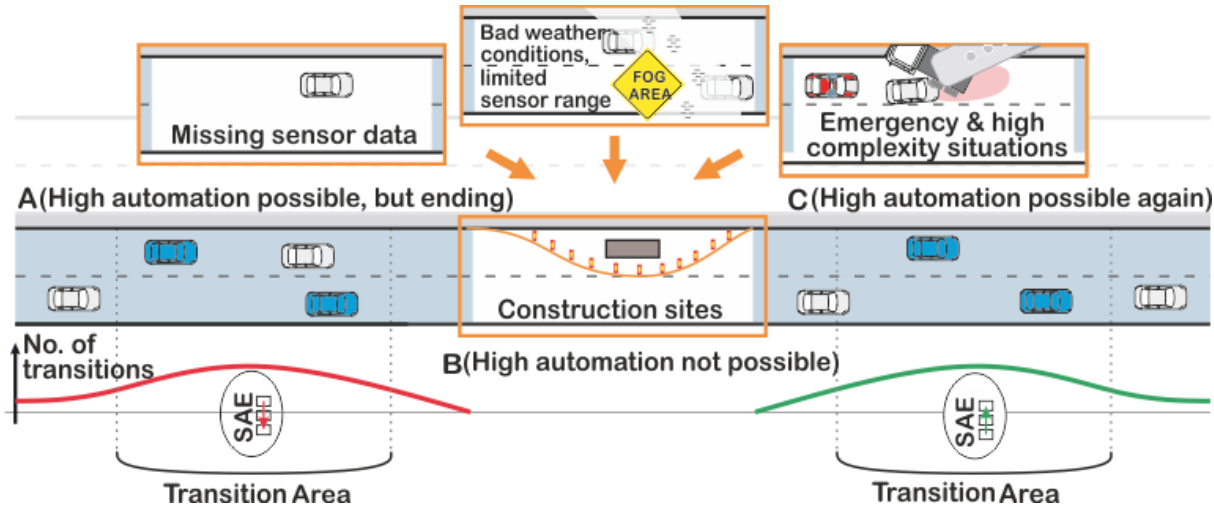
Project Overview



European H2020 project

- ART-05-2016 - Automated Road Transport
- Period: 01-09-2017 ~ 31-08-2020
COVID-19 Extension to 31-12-2020
possibly to 28-02-2021
- Budget: € 3,836,353
- 7 partners + 12 associated partners

Definition: "Transition Areas"

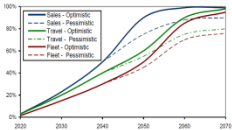
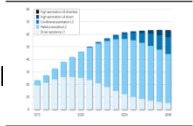
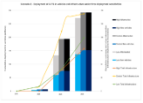


"Transition Areas" are areas on the road where many highly automated vehicles (blue) are changing their level of automation due to various reasons.

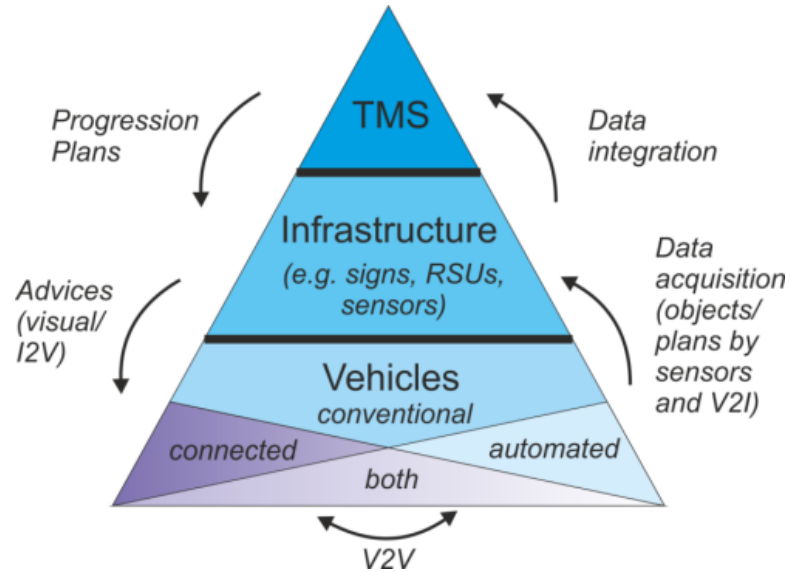
Analysis of effects of Transition Areas



Performed literature studies, expert interviews and stakeholder workshops with surveys
 → Various parameters (environmental causes, vehicle behaviour, HMI driver reaction, time ...)
 → only limited data available



Hierarchical approach



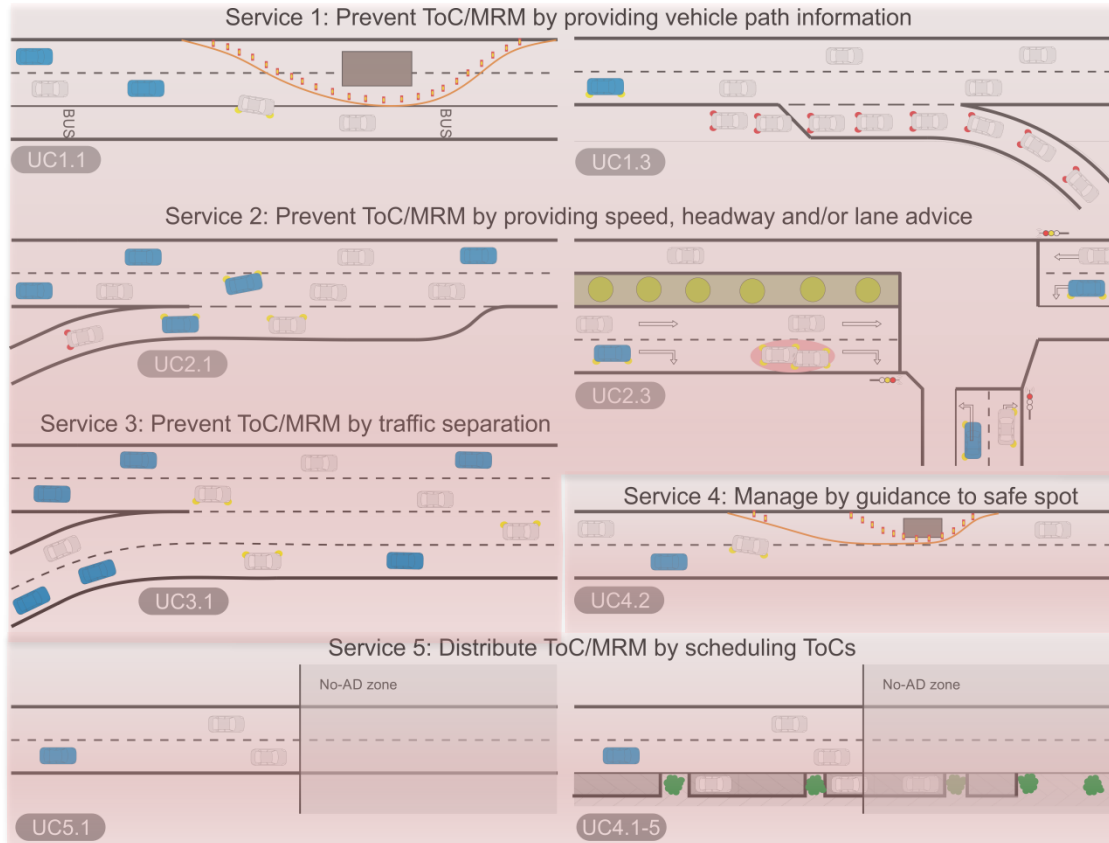
Traffic Management Service definition

Prevent ToC/MRM

Manage or support ToC/MRM

Distribute (in time and space) ToC/MRM

Investigated Use Cases



Each use case tested in several scenarios

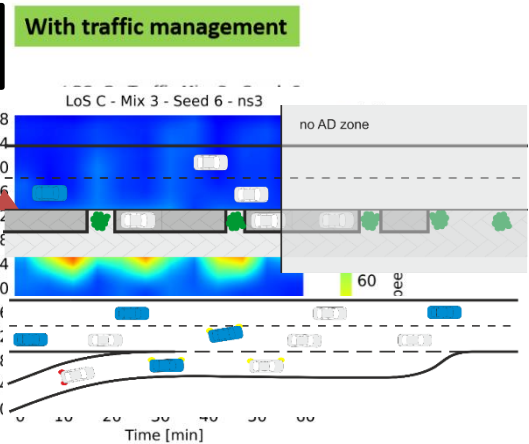
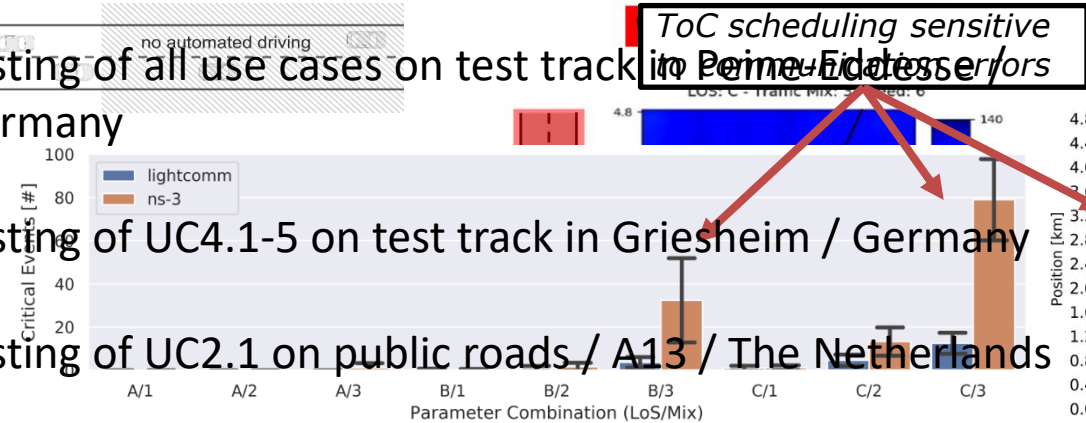
→ Sum of approx. 50 scenarios

Use case testing



1. Testing of all use cases on test track in **Perme Fildes / Germany**
2. Testing of UC4.1-5 on test track in Griesheim / Germany
3. Testing of UC2.1 on public roads / A13 / The Netherlands

ToC scheduling sensitive to parameter errors



V2X messages

- Purposes:
 - Extend RSI and CAVs perception and knowledge of the driving environment.
 - Support of TransAID Traffic Management Measures.
- Standard-compliant, backward compatibility and interoperability.

Extensions needed

Proposal

Optimization

CAM

DENM

MCM

CPM

MAPEM

SPATEM

Cooperative
Awareness
Message

Decentralized
Environmental
Notification
Message

Maneuver
Coordination
Message

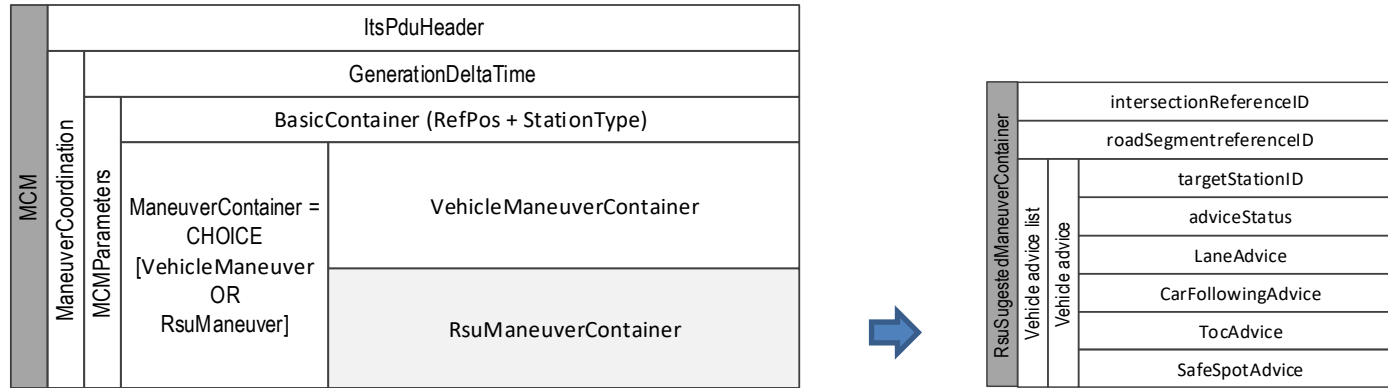
Collective
Perception
Message

MAP
Extended
Message

Signal Phase
Extended
Message

V2X messages

- Proposal for MCM message format:

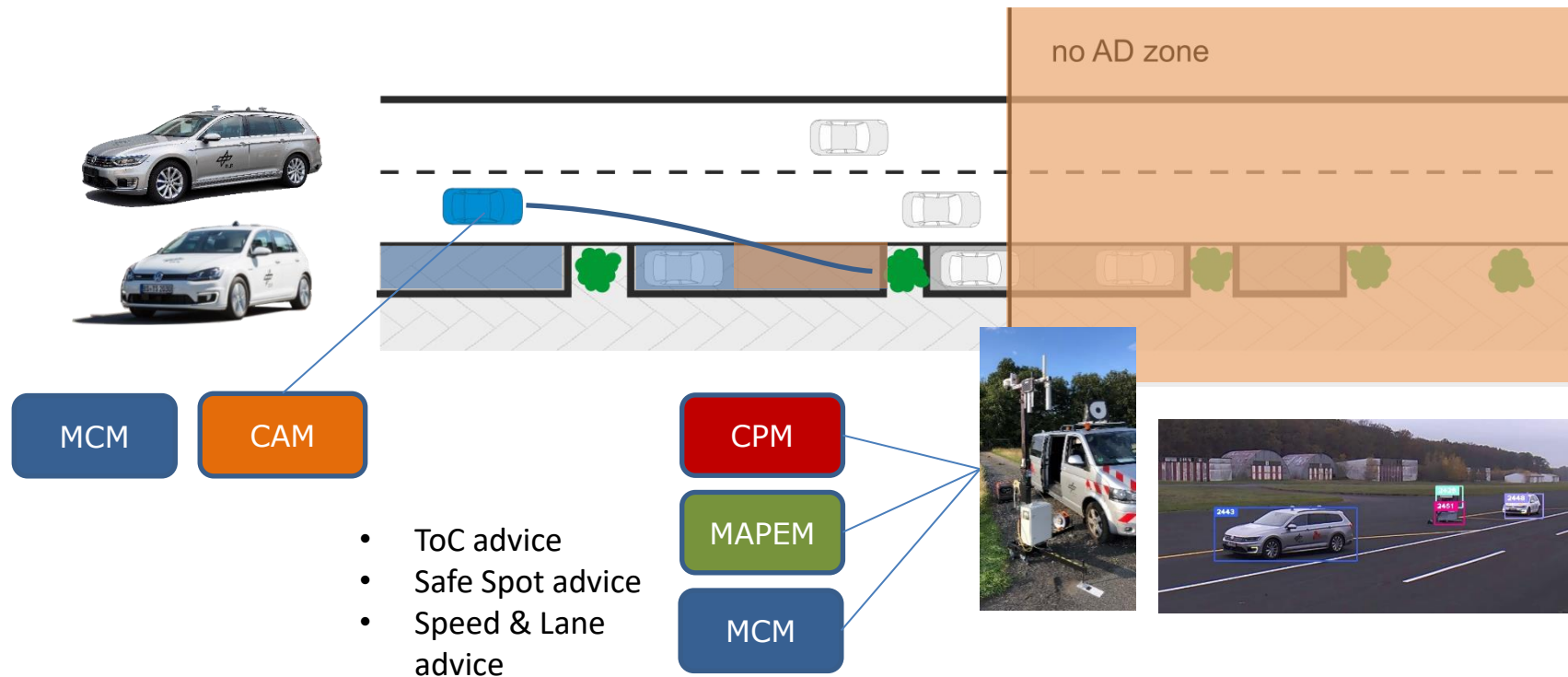


- Cooperative sensing: study and evolution of CPM generation rules.
 - Look-ahead mechanism and redundancy mitigation technique in [ETSI TR 103 562](#).
- Design and evaluation of techniques for improved V2X comms reliability:
 - V2X message compression, DCC reliability analysis, broadcast acknowledgement.



Field tests in Peine-Eddesse

UC4.1-5



Field tests in Peine-Eddesse

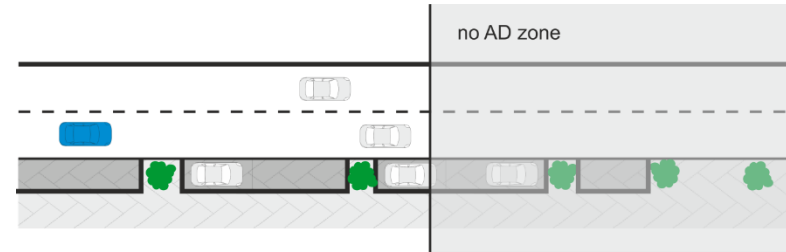
UC4.1-5



Detailed analysis: UC4.1-5

Griesheim test track

- Assessment of UC 4.1-5
 - Spatial distribution of TOR + safe spot advice
 - Day-1: TOR triggered by DENM



DENM-based Baseline approach



ToC triggered

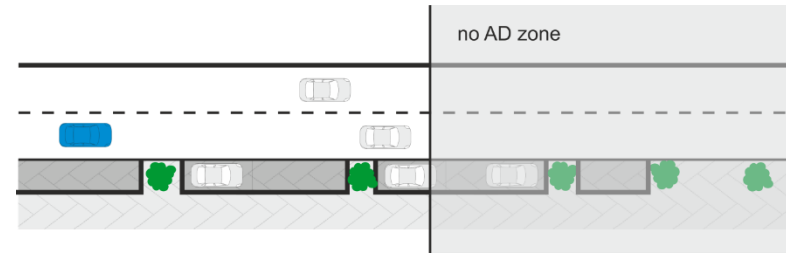
ToC timeout expired

MRM: as no safe spot available, stop on ego lane

Detailed analysis: UC4.1-5

Griesheim test track

- Assessment of UC 4.1-5
 - Spatial distribution of TOR + safe spot advice
 - Day-1: TOR triggered by DENM
 - TransAID approach: individual ToC and safespot advices



MCM-based TransAID approach

ToC point and safe spot location suggested

ToC triggered at suggested point

ToC timeout expired

MRM: automated driving to suggested safespot



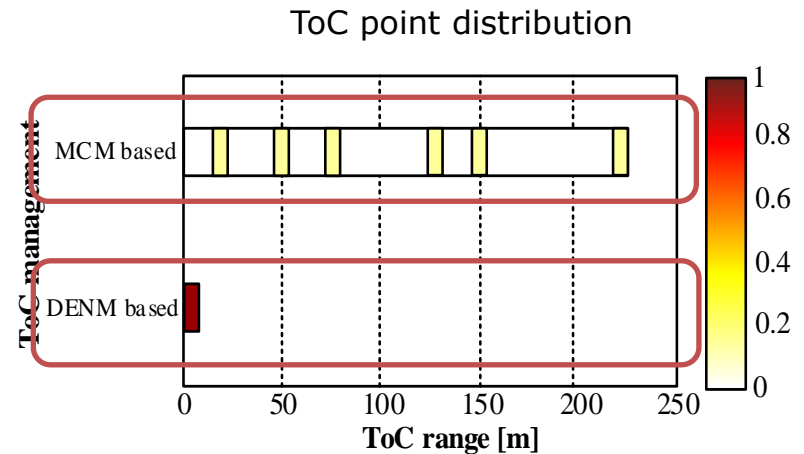
Detailed analysis: UC4.1-5

Griesheim test track

- Results:
 - TransAID ensures safe parking at safe spots in all scenarios and better distributes ToC points

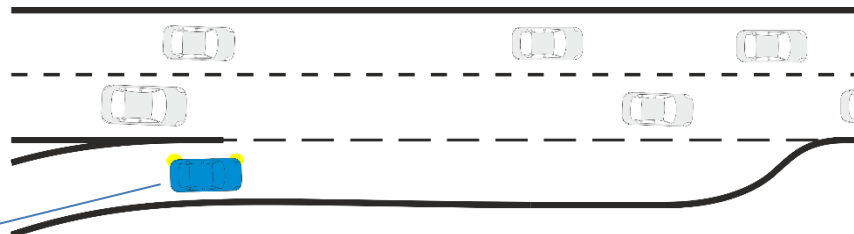
Successful MRM rate

DENM-based ToC Management	MCM-based ToC Management
12.5%	100%



Public road tests with CV on the A13

UC2.1



CAM

MCM

MCM

- Speed advice
- Lane advice
- ToC advice



Extended RSI deployments: two sets of inductive loops and RADAR camera data to augment CAVs' perception and to obtain accurately updated traffic input for speed and lane advice.

Public road tests with CV on the A13

UC2.1



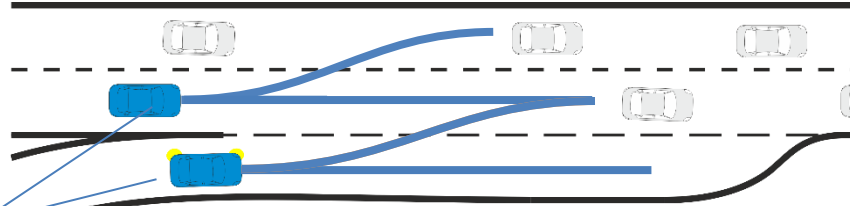
Comparison of ToC Rates: Emulation and field tests*

AVERAGE TOC RATE OF EMULATION (W/O MERGING ASSISTANT) AND FIELD TRIAL (W/- MERGING ASSISTANT)

Emulation	Field Trial
67%	0%

*Subject to human factors during the field trials and recreation of real traffic via emulation

Cooperative lane change extensions on test track - UC2.1



CAM

MCM

V2V-MCM

- Speed advice
- Lane advice
- ToC advice

MCM



Summary and next steps

- Feasibility of Traffic management measures shown
- Great potential of new messages and C-ITS
 - Esp. MCM with I2V-extensions offers good solutions
 - Also CPM allows collective perception, and benefits also for traffic management
- Next:
 - Full set of results presented in D7.2 in Jan. 2021
 - Roadmap and Guidelines for introduction released in Feb. 2021



Thanks for watching!
Questions?



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