



Transition Areas for Infrastructure-Assisted Driving

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Road infrastructure to support the transition to automation

H2020 call ART-05 – 2016

Specific challenge: ... highly automated vehicles will have to be managed in order to ensure an uninterrupted level of safety and efficiency. Road infrastructure will play a major role in managing this transition period.

...

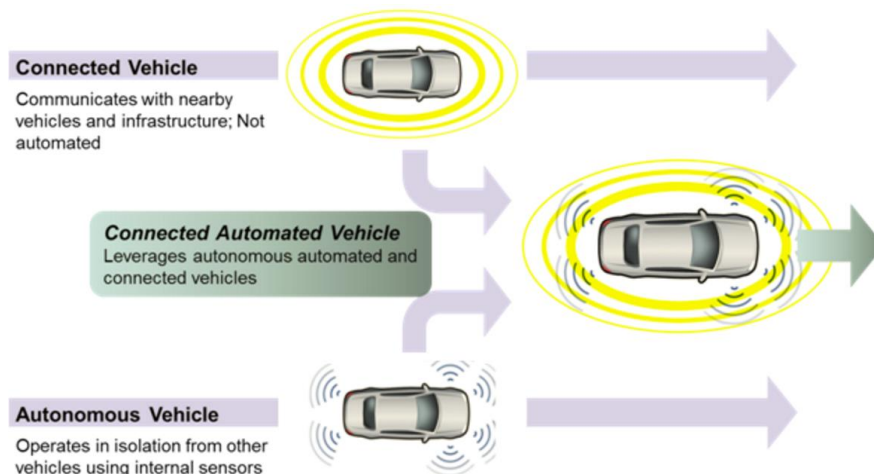
Required forms of visual and electronic signalling and optical guidance, ensuring readability by both automated and conventional vehicles, and enabling automated driving in also adverse road weather conditions.

...

Best ways to enlarge the electronic road horizon for automated vehicle ensuring timely reaction to hazards ahead via real-time warnings and information, traffic management plans, up-to-date digital maps, etc.

An intelligent environment *with infrastructure*

- Communication is a precondition for highly automated driving



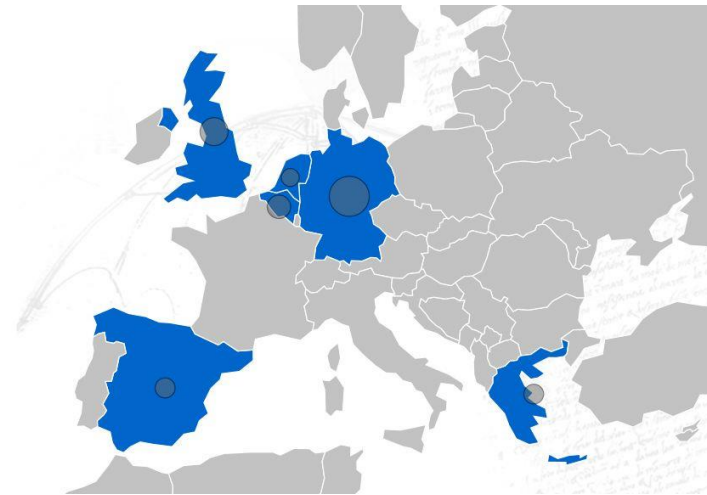
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- ‘Public’ traffic management and control remains necessary
 - Safeguard societal interests
 - Setting constraints and rules
 - Intervene in case of oversaturated conditions

Project overview

- TransAID (ART-05)
 - Transition Areas for Infrastructure-Assisted Driving
 - 01/09/2017 ~ 31/08/2019
 - Budget: EUR 3,836,353.75
 - Seven partners from 6 countries: DE, UK, BE, NL, EL, ES



Challenge



- ...what if your automated vehicle is not able to solve the situation ahead?
 - ...what, if this happens not to single vehicles only, but to several?
 - ...what, if it always happens on the same location?

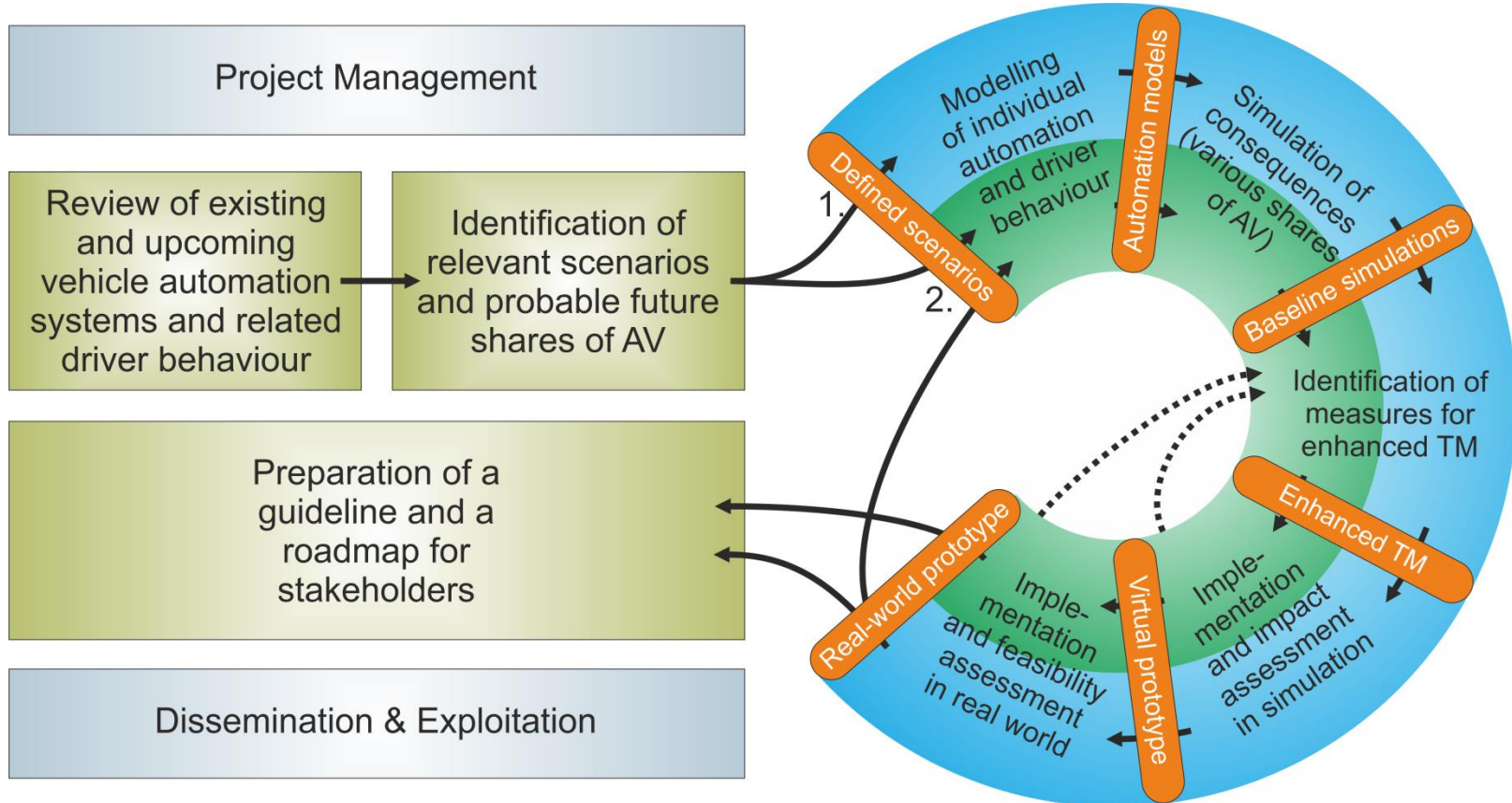
- Situation not understood
- Required action not possible
- Required action not allowed
- Required action not allowed without confirmation
- No response from the human driver
- Hardware or software failure



Contribution

- Infrastructure can:
 - Help to identify potential risks
 - Recommend solutions & suggested behaviour
 - Coordinate movements
- Develop and demonstrate **infrastructure-assisted** traffic management procedures and protocols for smooth coexistence between automated, connected, and conventional vehicles especially at **Transition Areas**.

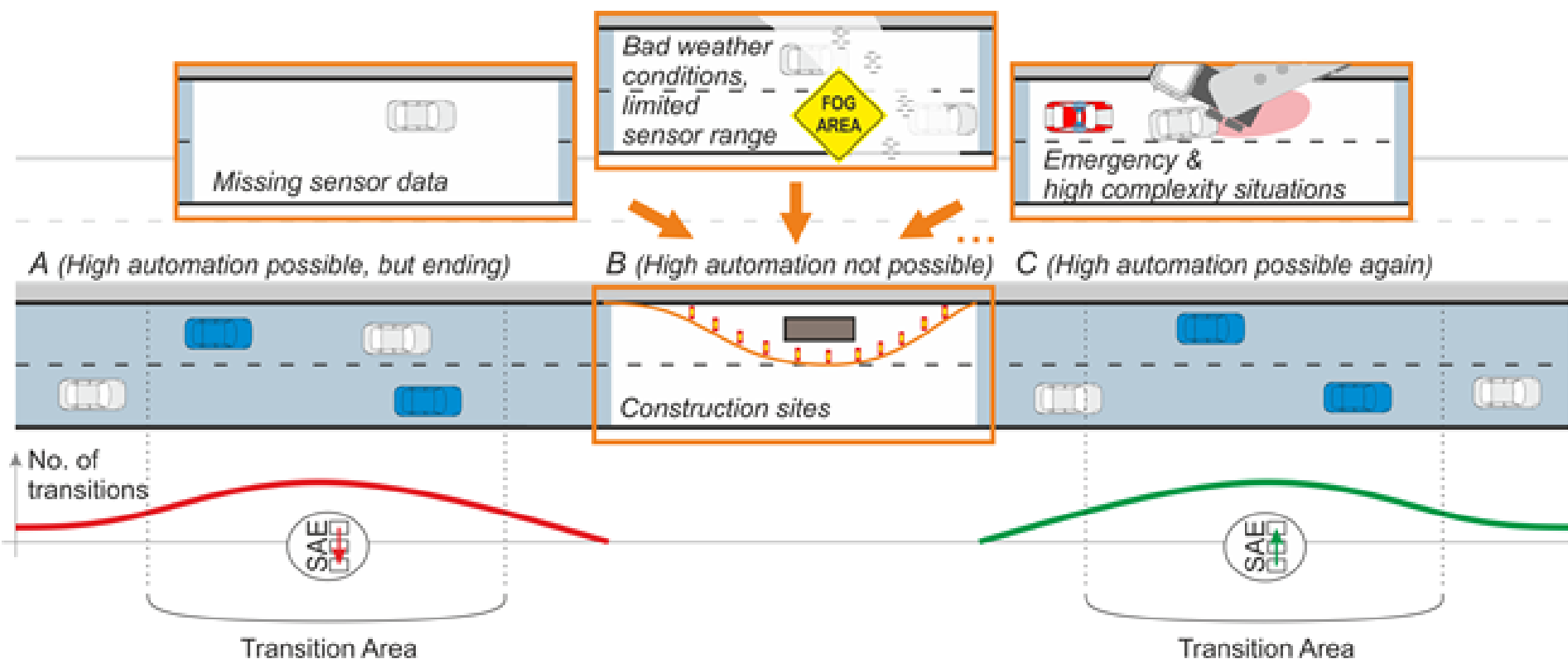
Approach



Expected results

- A simulation platform involving different
 - Vehicle behaviours
 - Penetration rates of vehicle systems
 - Traffic management procedures
- New V2X message sets
- A guideline for stakeholders like
 - Cities
 - Manufacturers
 - Infrastructure providers
 - Infrastructure operators
- A roadmap for a working system introduction

Transition Areas



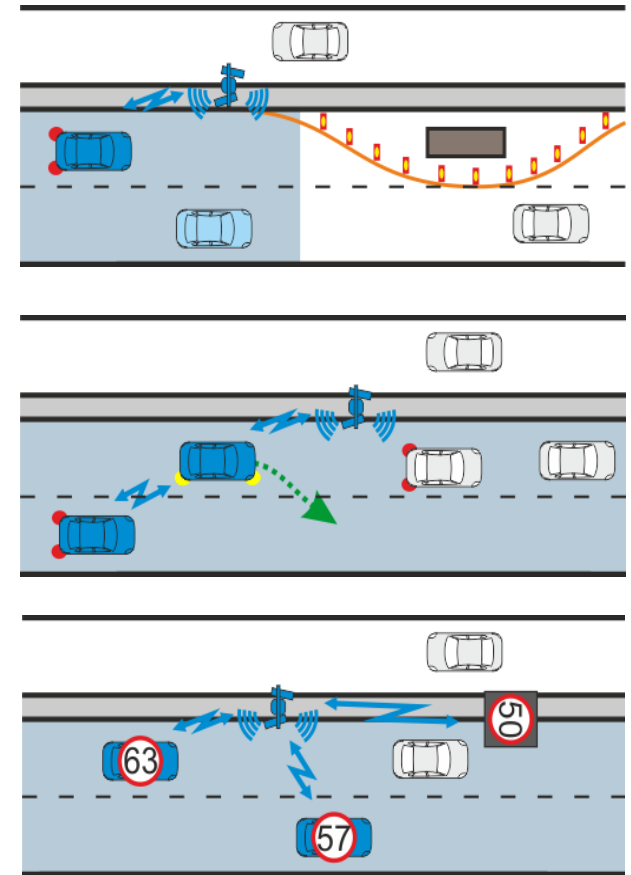
Scenarios and interventions

- **Scenarios**

- Work zones
- Signallised intersections
- Merging sections / off-ramps
- Incidents (accidents, sensors limitations)
- Weather conditions
- Any bottleneck...

- **Interventions**

- Transition to a different level of automation
- Location and time of transitions
- Traffic separation
- Lane / speed advisory
- Intersection pilot (MAVEN)



Truck Platooning



Objective break-out session



Break-out session

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TransAID concept



Questions for discussion

- AV-related:
 - What circumstances justify an ‘intervention’?
 - Which situations do you expect to be ‘risky’?
 - Where is an AV non-desirable?
 - Which uncertainties exist for you?
 - What are your priorities in this context?
- Operational:
 - What is the role/task of road authorities?
 - What is the role/task of (digital) infrastructure?
 - What (operational) measures could & should be taken?

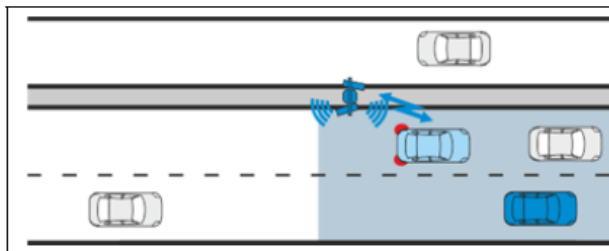
	SAE Level	Name	Steering, acceleration, deceleration	Monitoring driving environment	Fallback performance of dynamic driving task	System capability (driving modes)
Human monitors environment	0	No automation the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems				
	1	Driver assistance the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task.				Some driving modes
	2	Partial automation the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task				Some driving modes
Car monitors environment	3	Conditional automation the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene				Some driving modes
	4	High automation the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene				Some driving modes
	5	Full automation the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver				All driving modes

Red are primary reasons. Green are secondary reasons

Vertical transitions occur because of the 'driving mode' (the disruption/situation)

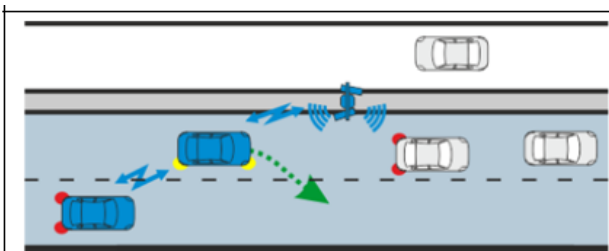
Horizontal transitions are the consequence of vehicle-internal limitations

Complex situations (1/3)



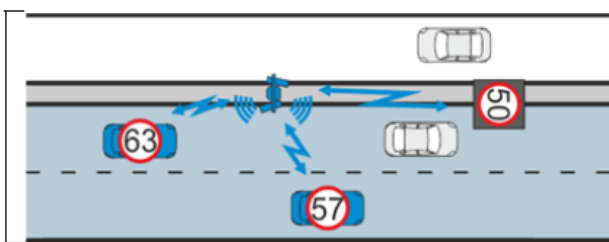
Transition to higher levels of automation

The optimal behaviour and timing when switching to higher SAE levels is calculated by the infrastructure depending on the overall situation. This includes speed changes and probable joining of platoons.



Lane changes

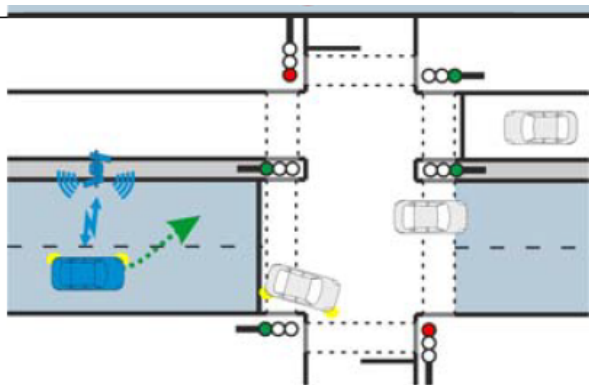
Due to high traffic loads on certain lanes, the traffic management system might recommend certain vehicles to change lane or even to take an alternative route. V2X-communication or variable traffic signs are used to inform the driver/automation.



Speed changes

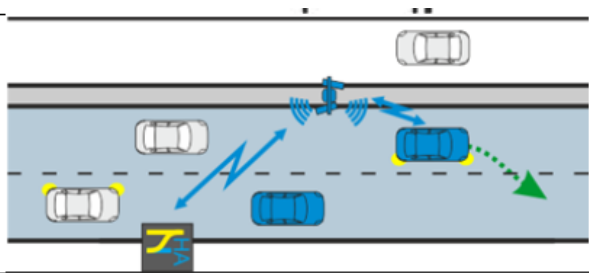
The infrastructure may optimise the traffic flow by changing the recommended speed for groups of vehicles. Connected vehicles may get individual recommendations for a maximised impact.

Complex situations (2/3)



Intersection handling

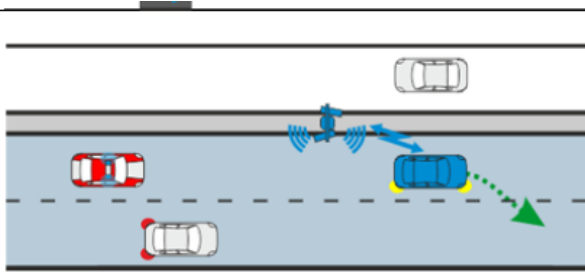
Intersections require special handling, as e.g. vehicles may be guided to other lanes due to turning manoeuvres. Signalised intersections are also used to influence the traffic flow when this is beneficial for the upcoming areas.



Traffic separation

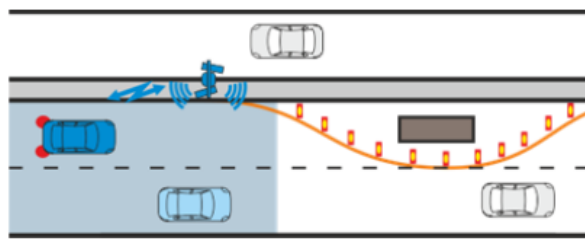
In some situations (or when decided by an operator) it might be valuable that vehicles of specific automation levels are dedicated to certain lanes, e.g. highly automated driving on the right, all others on the left.

Complex situations (3/3)



Emergency situations

Arrival of emergency vehicles has a large impact on traffic situations. As vehicles ought to make way, the same is true for automated vehicles. Traffic management can help both the traffic and the emergency vehicles to safely proceed, by deciding on optimal behaviour, especially inside Transition Areas.



Transition to lower levels of automation

The infrastructure helps the automated vehicles to hand back control to the driver, as reasons for the transition (e.g. positions of construction sites) and guidelines for the optimal behaviour and timing can be given. In case of a failed transition, optimal kinds of Minimum Risk Manoeuvres can be suggested by the infrastructure.

Agenda break-out

- Quick round of introduction (stakeholders)
- Explain session objectives
- Introduction to TransAID concept
- Brainstorm / exchange ideas and views
- Summary / homework

Objectives

To develop and demonstrate **infrastructure-assisted traffic management procedures, protocols and guidelines** for smooth coexistence between automated, connected and conventional vehicles especially at Transition Areas.

Evaluation and modelling of **current automation prototypes** and their drivers' behaviour.

Assessment of the **impact** of Transition Areas **on traffic safety and efficiency**. Generate requirements on enhanced traffic management procedures.

Development of **infrastructure-assisted management procedures and protocols** to control connected, automated and conventional vehicles at Transition Areas.

Definition of **V2X message sets and communication protocols** for the cooperation between connected/automated vehicles and the road infrastructure

Development of procedures to enhance the **detection of conventional vehicles** and obstacles on the roads and to inform/influence conventional vehicles.

Integration, test and evaluation of the TransAID infrastructure-assisted traffic management protocols and procedures in a simulation environment. **Validation and demonstration** of them by means of real world prototypes at test sites.

Provision of a guideline/roadmap to stakeholders regarding the requirements on traffic infrastructure and traffic management in order to cope with Transition Areas considering mixed traffic.