

# I2V applications for intersections and transition areas

orchestrate  
adaptivity  
communication  
support **HAVS** negotiation  
monitor  
infrastructure  
intersection  
trajectory  
platoon scheduling

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**MAP** >>  
TRAFFIC MANAGEMENT

Automated Vehicle Symposium 2017, 12 July 2017, San Francisco  
*Breakout 18: Reading the Road Ahead: Infrastructure Readiness*



MAVEN is funded by the EC Horizon 2020 Research and Innovation Framework Programme, under Grant Agreement No. 690727



# Safe and connected automation

## H2020 call MG3.6a - 2015

Specific challenge: Automated and progressively autonomous driving applications in road transport, actively interacting with their intelligent environment could provide an answer to the EU objective of reconciling growing mobility needs with more efficient transport operations, lower environmental impacts and increased road safety.

...

Automation in road transport should make best use of the evolution of Cooperative ITS and the benefits made available by satellite navigation systems, such as the increased accuracy and robustness.

...

Novel transport, service and mobility concepts in real-life situations enabled by automated driving and connectivity. These services and concepts could benefit from cloud computing and data management and data aggregation techniques for road transport big data.



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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.

...

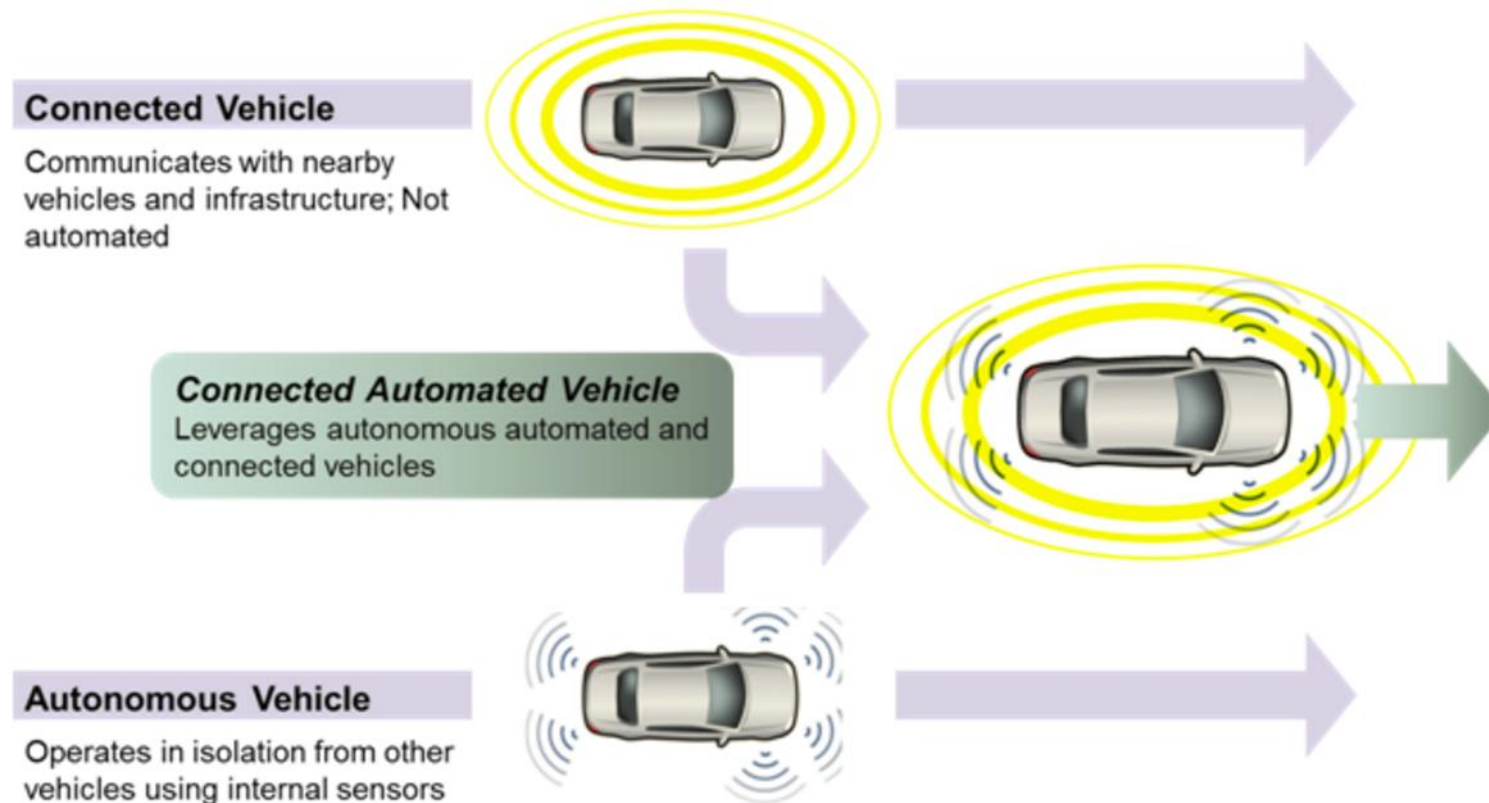
Best ways to enlarge the electronic road horizon for automated vehicle ensuring timely reaction to hazards ahead via real-time warnings and information, traffic management plans, up-to-date digital maps, etc.



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# Connected automation



source: Thinkstock/USDOT



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# An intelligent environment *with infrastructure*

- ❑ **Communication a precondition for highly automated driving**
- ❑ **'Public' traffic management and control remains necessary**
  - ✓ Safeguard societal interests
  - ✓ Setting constraints and rules
  - ✓ Intervene in case of oversaturated conditions
- ❑ **Offers new possibilities for optimisation in traffic management and control**
- ❑ **Three operational perspectives:**
  - ✓ Each vehicle individually (autonomous)
  - ✓ Vehicles part of a group process (e.g. platoon)
  - ✓ Vehicles part of a system process (e.g. intersection control)



# Projects overview

## ❑ MAVEN (MG3.6a)

- ✓ Managing Automated Vehicles Enhances Network
- ✓ 01-09-2016 ~ 31-08-2019
- ✓ Budget: EUR 3.149.661,25
- ✓ Nine partners from five countries: DE, NL, CZ, BE, UK

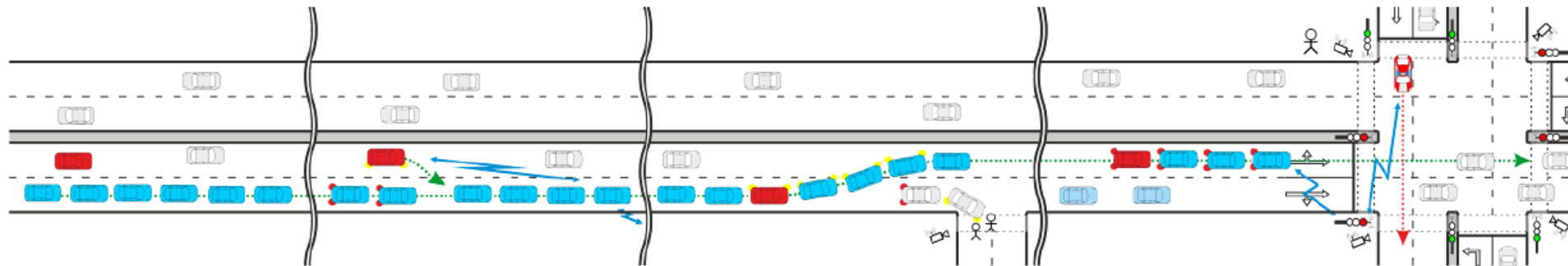
## ❑ TransAID (ART-05)

- ✓ 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



# MAVEN project summary

- ❑ MAVEN will develop **management regimes** for highly automated driving in **urban areas**.
- ❑ Road infrastructure will be able to **monitor, support and orchestrate** vehicle and VRU movements to guide vehicles at **signalized intersections** and corridors in urban areas.
- ❑ Beyond the state-of-the-art of ADAS and C-ITS services like GLOSA, by adding cooperative **platoon organization** and signal plan negotiation to **adaptive traffic light control**.
- ❑ Develop suitable enables technologies, e.g. **communication protocols**, and test and validate via simulation and real-world prototype (ITS-G5 based).



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# Infra-initiated and/or infra-assisted

## ❑ Platoon management (**group process**)

- ✓ Forming, joining, progression, leaving, breaking a platoon

## ❑ Infrastructure-to-vehicle interactions (**system process**)

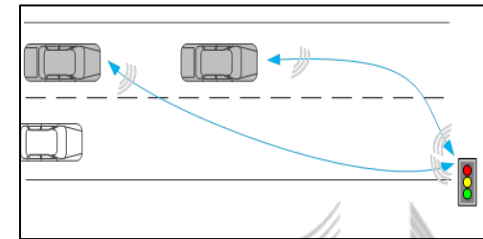
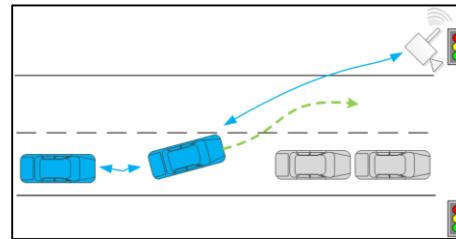
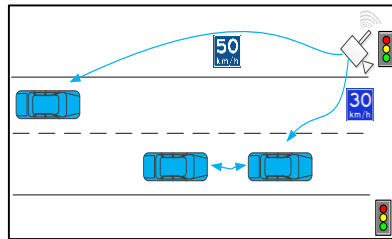
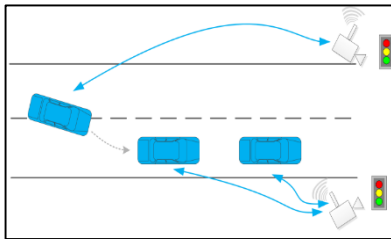
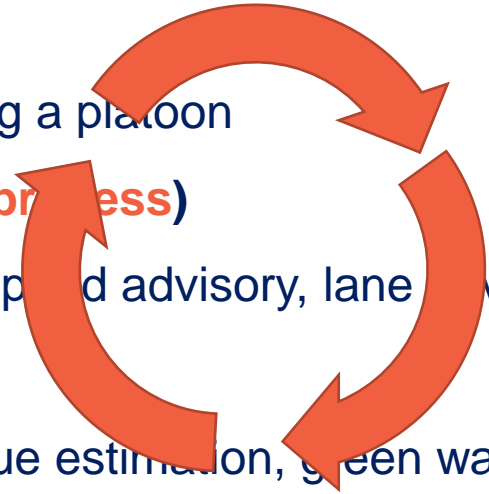
- ✓ Negotiation (signal timing vs. arrival pattern), speed advisory, lane advisory

## ❑ Traffic control optimization (and scheduling)

- ✓ Signal optimization, priority management, queue estimation, green wave

## ❑ Conventional traffic and vulnerable road users

- ✓ Detection of non-cooperative vehicles, VRUs, emergency situations



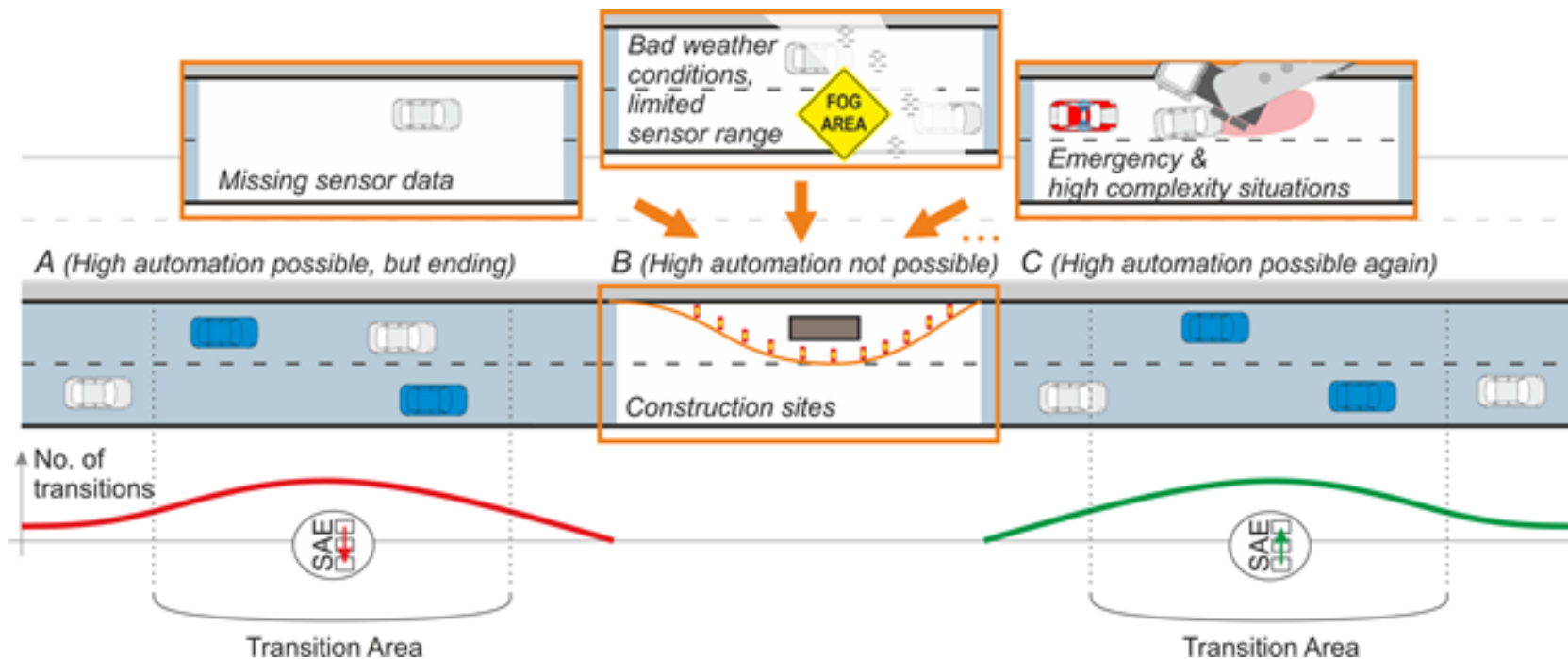


# A broader context: TransAID project summary

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



# Transition Areas



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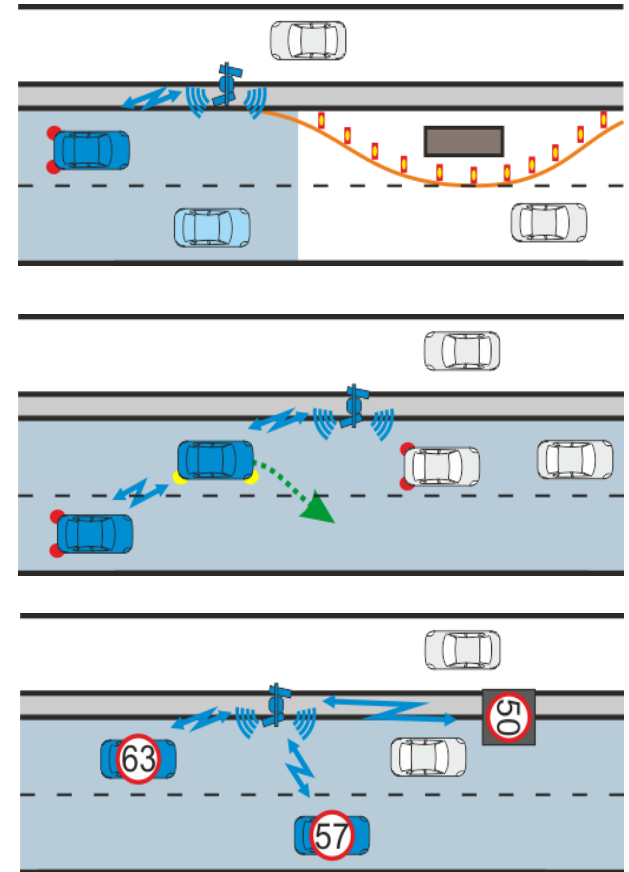
# TransAID scenarios and interventions

## ❑ Scenarios

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

## ❑ Interventions

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



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# The case of Truck Platooning



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# Necessary V2X extensions

## ❑ V2I – e.g. Cooperative Awareness Message (CAM)

- ✓ Planned manoeuvre (intention);
- ✓ Desired speed range;
- ✓ Platoon properties (size, length, roles, speed, headway, composition, etc.);
- ✓ Acknowledgments of intentions and compliance (negotiation).

## ❑ I2V – e.g. Signal Phase and Timing Message (SPAT) or new message (?)

- ✓ Differentiated speed advisory;
- ✓ Lane advisory;
- ✓ Appropriate headway;
- ✓ Maximum platoon length or prohibition;
- ✓ Feasible level of automated driving.



# To conclude

- ❑ Infra-assistance for highly automated driving
  - ✓ Managing Automated Vehicles Enhances Network (MAVEN)
  - ✓ Transition Areas for Infrastructure-Assisted Driving (TransAID)
  - ✓ Truck Platooning (Real-Life Cases Program)
- ❑ A necessity but also a new dimension of Traffic Management and Control
  - ✓ Explicit intervention (control)
  - ✓ Implicit response (inform)
- ❑ Many ideas and concepts, equal amount of questions: explorative research!
- ❑ Great interest (local) road authorities in guidelines and broader city mobility context



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# Visit me @ today's reception

Munich, Germany  
4-5 July 2017  
mobile.TUM.2017

## MAVEN

Managing Automated Vehicles Enhance Network

The 3-year EU-funded MAVEN project aims to develop solutions for managing level-4 HAVs at (urban) signalized intersections. It will develop algorithms for infrastructure-initiated guidance of HAVs using negotiation protocols between vehicles and the infrastructure. Iteratively, HAVs receive advice and/or commands from the road infrastructure to adjust their trajectory and maneuvering policies, while the infrastructure dynamically adapts the traffic light timing of single or multiple signalized intersections based on the anticipated vehicle arrival pattern. The MAVEN project will build a system prototype that will be used both for field tests and modelling.

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**USE CASES**

- I2V Interactions
  - Negotiation (signal timing vs. arrival pattern)
  - Speed change advisory
  - Lane change advisory
- Platoon management
  - Forming
  - Joining
  - Progression
  - Leaving
  - Breaking a platoon

- Traffic controllers optimization
  - Signal optimization
  - Priority management
  - Queue estimation
  - Green wave
- Conventional traffic and VRUs
  - Detection of non-cooperative vehicles
  - VRUs
  - Emergency situations








**PROJECT CONSORTIUM**














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