MAVEN

Managing Automated Vehicles Enhances Network

Dr. Meng Lu

dynniq

This project has received funding from the European Union's Horizon 2020 research and innovation programme

General information of MAVEN

- MAVEN - Managing Automated Vehicles Enhances Network
  - Web site: www.maven-its.eu
  - LinkedIn: www.linkedin.com/groups/8571587/profile
  - Twitter: @MAVEN_its
- Project period: 36M (01-09-2016 to 31-08-2019)
- Funded by the EC Horizon 2020 Research and Innovation FP, under Grant Agreement No.690727
- Budget > EUR 3 mil.
- Consortium

dynniq, DLR, HYUNDAI MOTOR GROUP, MAP TRAFFIC MANAGEMENT, TOMTOM, POLIS CITIES AND REGIONS FOR TRANSPORT INNOVATION, CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE, Gemeente Helmond, ROYAL borough of GREENWICH

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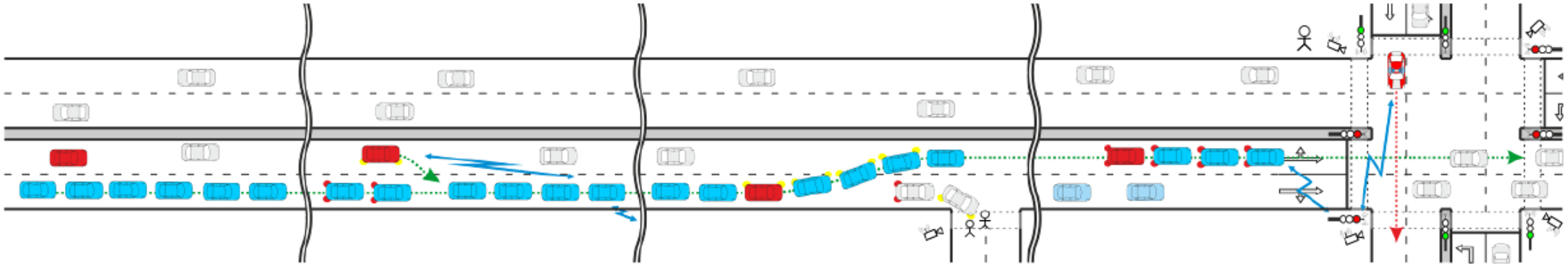
MAVNE objectives

- Develop management regimes for highly automated driving in urban areas
- ICT infra will monitor, support and orchestrate vehicle and VRU movements to guide vehicles at signalized intersections and corridors
- Enhancement for ADAS and C-ITS applications
  - ✓ safety with collective perception
  - ✓ efficiency by exploiting possibilities of AD driving



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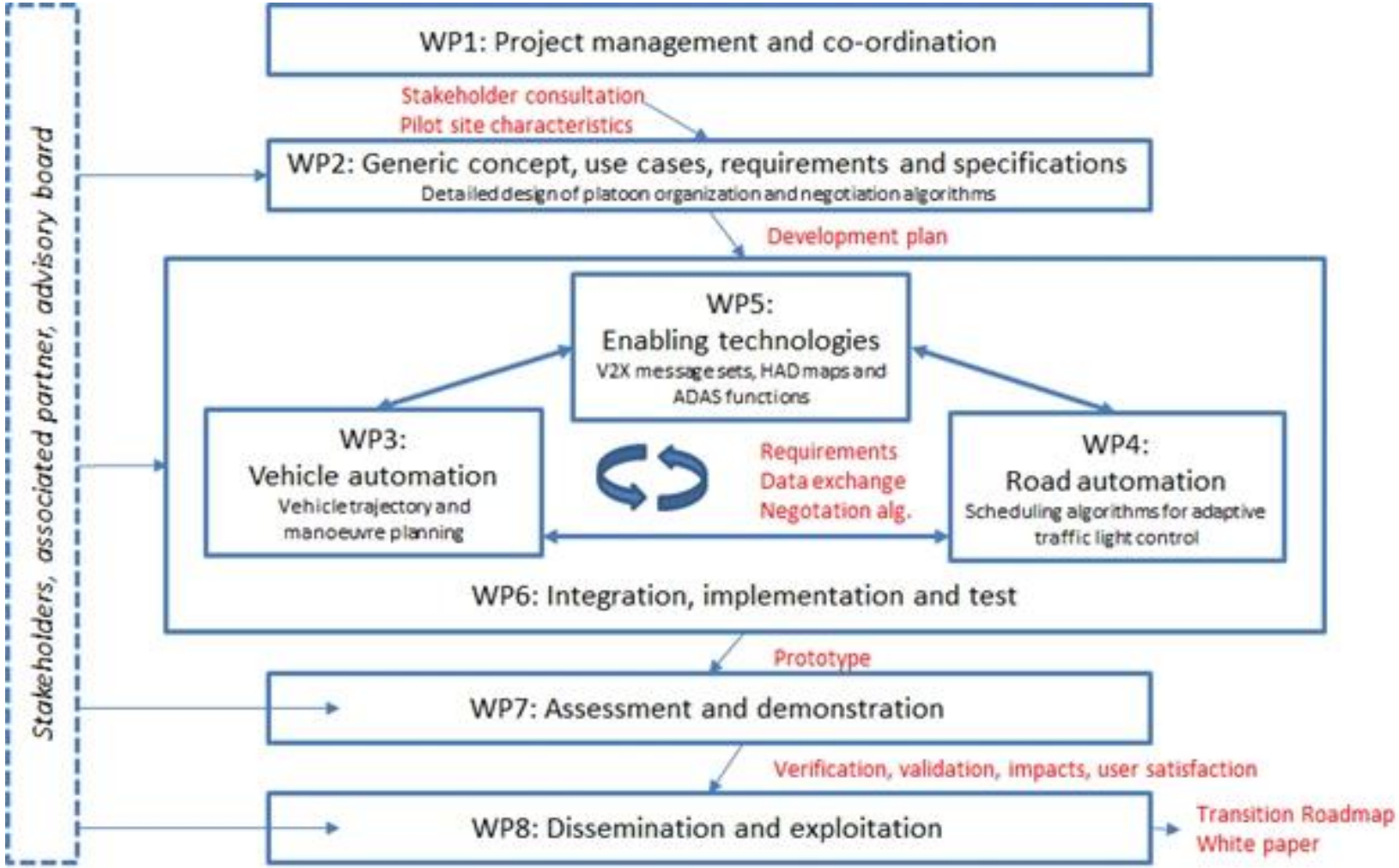
MAVNE apporach



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MAVEN use cases and new data elements

Cluster/platoon mgmt	Longitudinal / lateral mgmt	Signal optimisation	Intersection/other road user
UC1: Cluster/platoon initialisation UC2: Joining a cluster/platoon UC3: Travelling in a cluster/platoon UC4: Leaving a cluster/platoon UC5: Cluster/platoon break-up UC6: Cluster/platoon termination	UC7: Speed change advisory (GLOSA - Green Light Optimal Speed Advisory) UC8: Lane change advisory UC9: Emergency situations	UC10: Priority management UC11: Queue length estimation UC12: Local level routing UC13: Network coordination – green wave UC14: Signal optimisation	UC15: Intersection negotiation UC16: Detect non-cooperative road users

New data element	Applicable scenario
Number of occupants	Intersection priority management.
Distance to following vehicle	Queue estimation. This information can improve queue model accuracy, leading to more optimal solutions for GLOSA negotiation and signal timing
Distance to preceding vehicle	
Platooning state	Signal optimization and intersection priority
Desired speed	Queue estimation and GLOSA negotiation
Current lane	Lane advice, multiple lanes for a certain direction
Route information	Queue estimation, signal optimization and GLOSA

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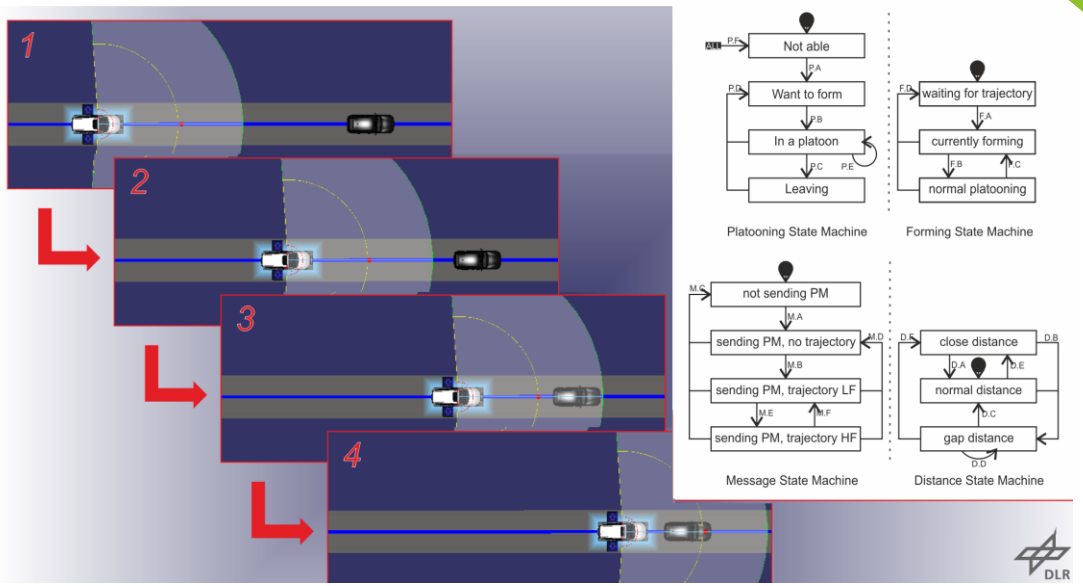
MAVEN results - Vehicle automation

- MAVEN multi-layer vehicle automation concept
  - ✓ trajectory planning ensures the vehicle drives an optimal path within the lane on a short horizon
  - ✓ tactical level takes input from V2V and V2I communication and platoon algorithms to control the vehicle on a higher level
    - platooning, lane changes and optimal speed for approaching an intersection are the main targets
    - for platooning a detailed algorithm based on a state-machine and supported by the new message sets has been developed



Platooning state machine for fully automated cooperative vehicle

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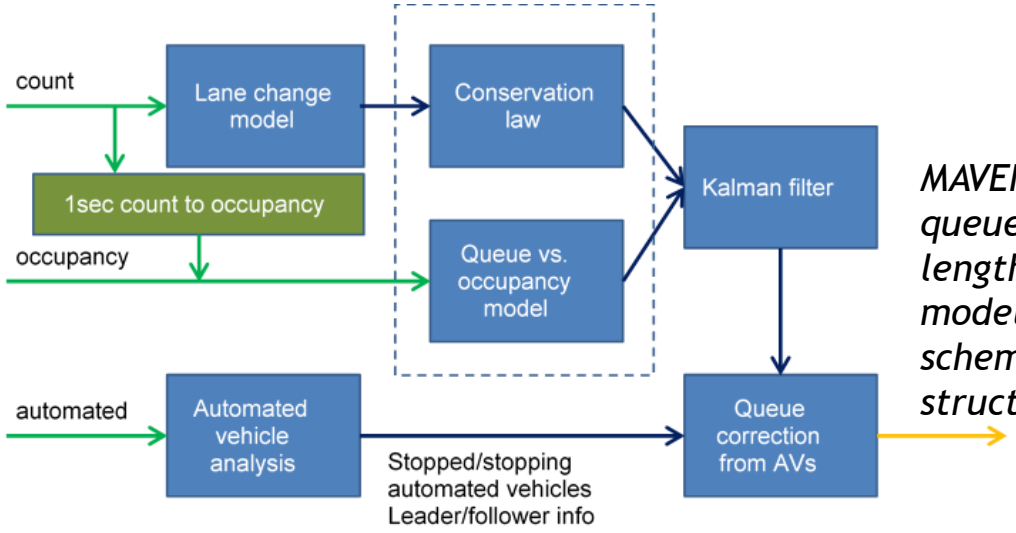
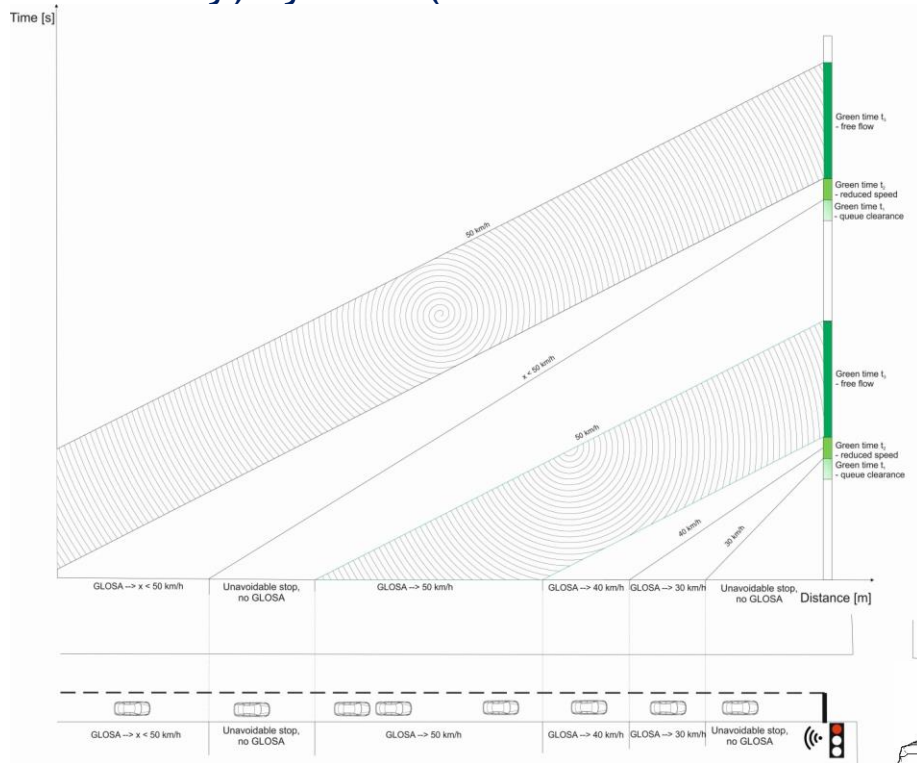
MAVEN results – Infrastructure automation

- Scheduling and signal timing strategy prototype and conducted three demonstrations
  - ✓ improved countdown stability of the adaptive traffic control algorithm
  - ✓ complete MAVEN system deployed in Helmond (external queue model interface & control algorithm)
  - ✓ AGLOSA (Agent-based Green Light Optimal Speed Advisory) system (SUMO and traffic control h/w)



MAVEN queue length model schematic structure



Actuated traffic control with GLOSA

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MAVEN results - V2X communication for automated driving

- Development of V2X communication schemes and message sets
  - ✓ for cooperative infrastructure: development of I2V Lane Change Advisory service; dedicated profiling of the SPaT and MAP for lane-specific GLOSA
  - ✓ for cooperative automated vehicles: design of extensions of standard CAM (Cooperative Awareness Message) messages to allow interaction with cooperative intersections and to support management and control of platoons
  - ✓ currently under standardization Collective Perception service has been adapted to the needs of MAVEN to support the applications of cooperative and automated vehicles aimed at increasing the safety of VRUs and drivers
- Actively contribution to the ETSI standardisation, especially for the Collective Perception definitions; other communications schemes were presented for further consideration in standardization & specifications organizations like ETSI ITS and C2C CC in dedicated events

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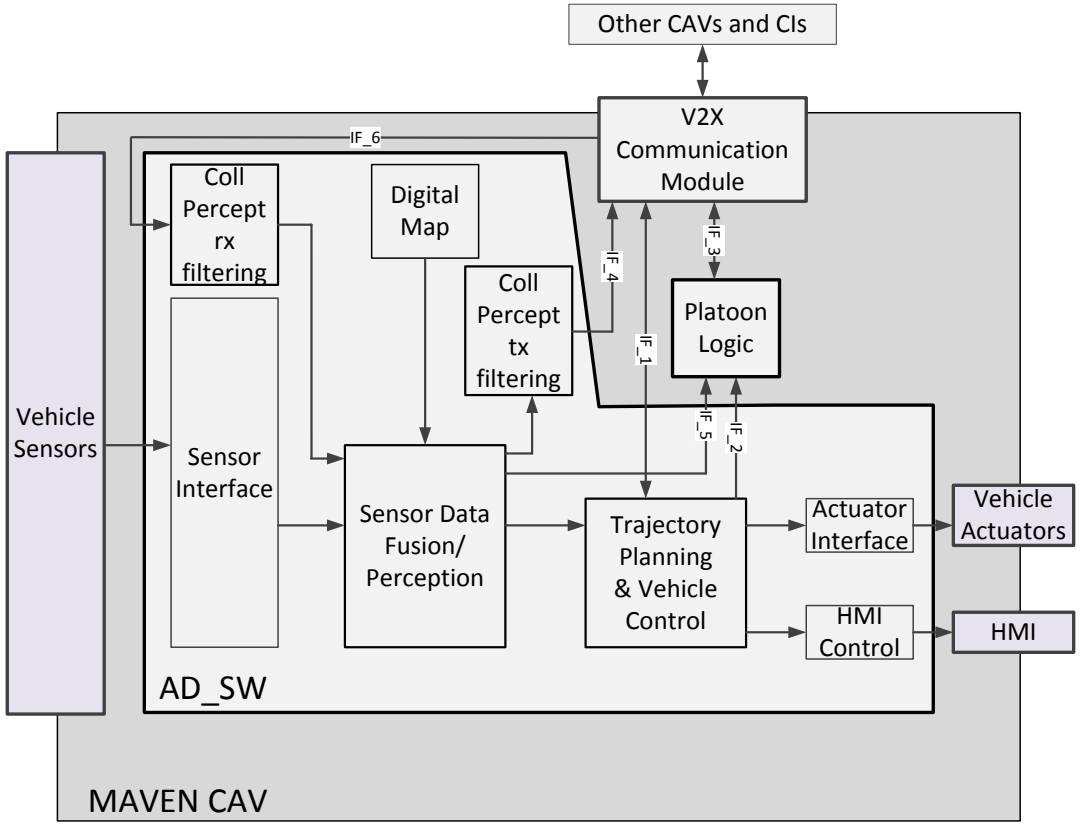
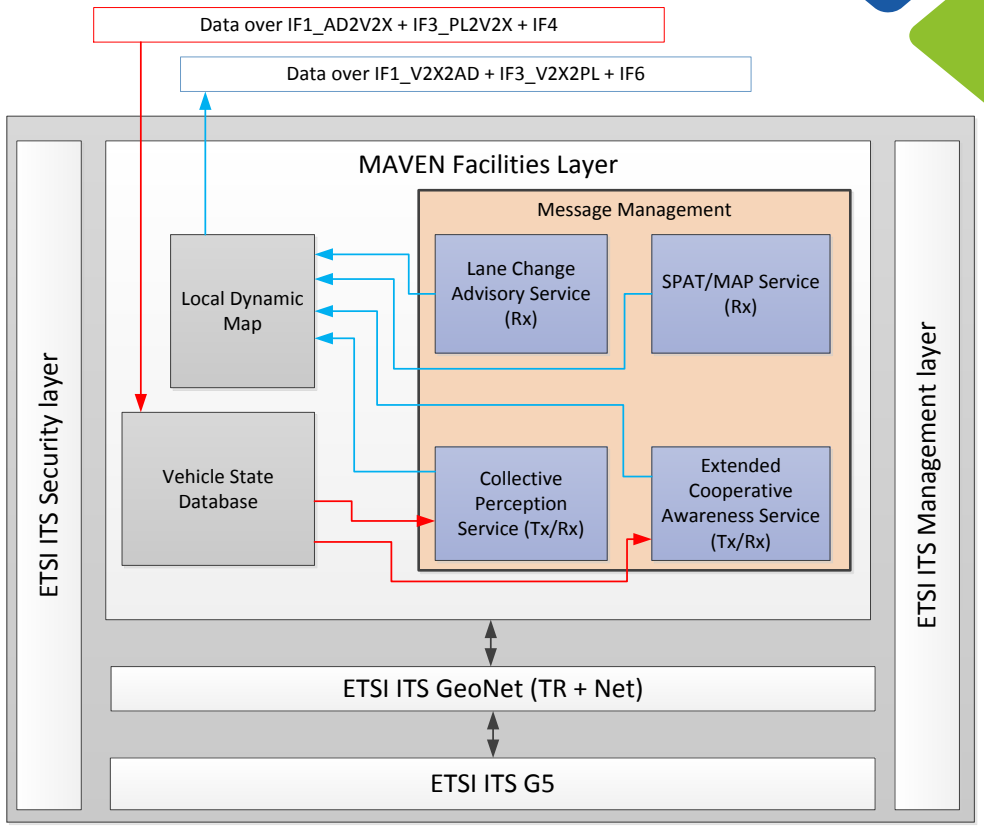
MAVEN results - V2X communication architectures



MAVEN cooperative and automated vehicles communication architecture and interfacing



MAVEN V2X communication module architecture

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Expected further results – Technical development and pilots

- Further technical development
  - ✓ detailed concepts for cooperative manoeuvre and trajectory planning, and for in-vehicle cooperative environment perception
  - ✓ cooperative environment perception algorithms
  - ✓ cooperative manoeuvre and trajectory planning algorithms
  - ✓ cooperative adaptive traffic light optimization with automated vehicles
- Pilot and technical workshop plan
  - ✓ MAVEN demo, in conjunction with European Congress on Intelligent Transport Systems on 3-6 June 2019, Eindhoven/Helmond
  - ✓ Joint Workshop with TransAID, in conjunction with IEEE IV'19 (Intelligent Vehicles Symposium) on 9-12 June 2019, Paris

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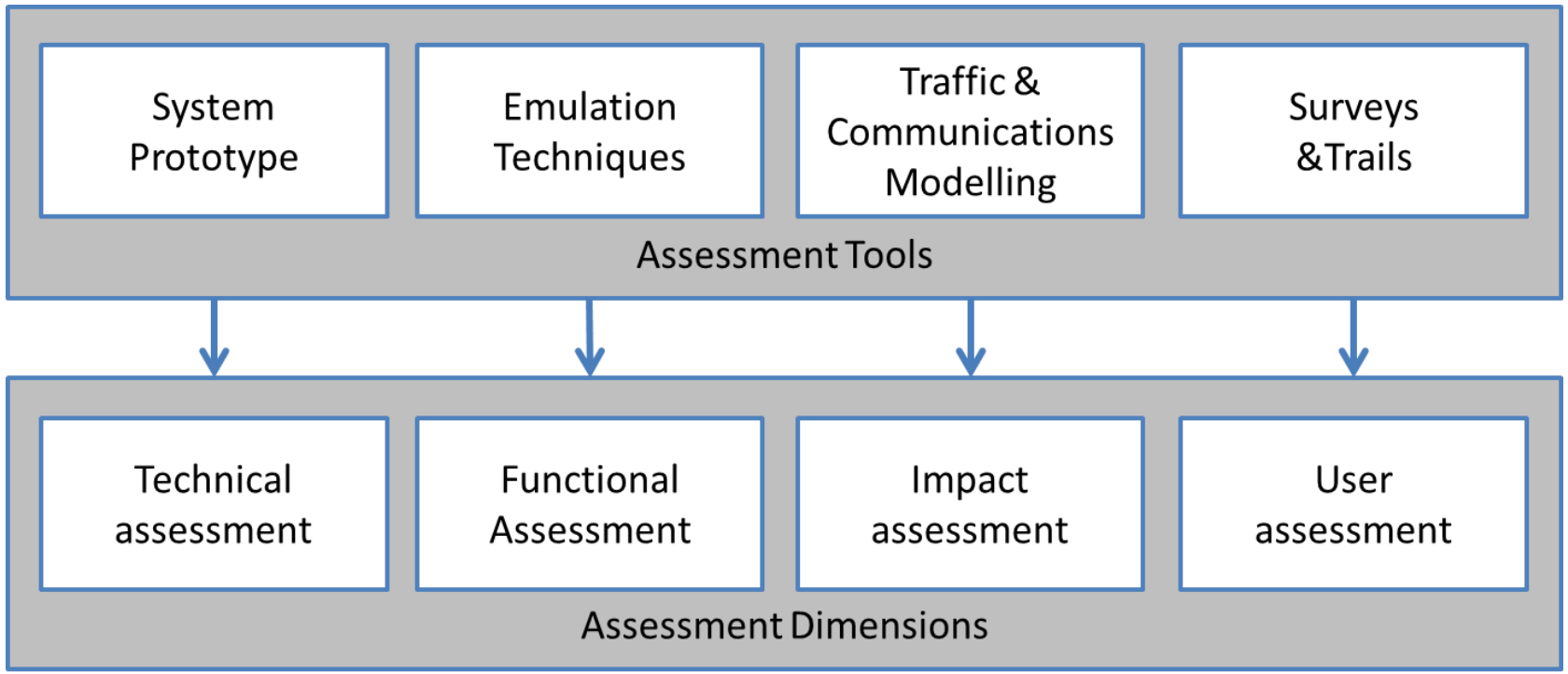
Expected further results - Validation and impact assessment of cooperative and automated driving



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Expected further results – Transition to the TM of connected and automated vehicles

- MAVEN Transition roadmap
  - ✓ from a city authority and traffic managers perspective
  - ✓ MAVEN use cases implementation
  - ✓ technological, organisational, legal/liability, cultural, financial, and policy perspectives
  - ✓ factors to the city authorities that will influence the transition, e.g. vehicle penetration levels, legal framework, and user acceptance
- MAVEN White Paper on "Management of automated vehicles in a smart city environment"
  - ✓ use cases for remote management and control of automated vehicles in cities
  - ✓ new ways to balance demand and supply to manage scarce space and road capacity
  - ✓ new concepts for management of unmanned vehicles and service vehicle
  - ✓ impact on the shape and form of cities (e.g. land use and mobility), and further research and innovation activities

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Expected impact (long-term) of the project – based on the achievements

- Technological impacts
  - ✓ enabling implementation of new technologies in vehicles
  - ✓ developed V2X communication schemes are backward compatible as required by the car industry and to foster their future deployment
  - ✓ contribution to the ETSI standardisation
- Social, economic, environmental impacts
  - ✓ safety with collective perception
  - ✓ energy efficiency by exploiting possibilities of AD driving
  - ✓ traffic efficiency in urban areas with mixed traffic

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Thank you!

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