CONNECTING CULTURES
ENABLING ECONOMIES
6th to 10th October 2019

INFRASTRUCTURE-ASSISTED MANAGEMENT FOR MIXED TRAFFIC AT TRANSITION AREAS

FORESIGHT SESSION 10
CONNECTED & AUTONOMOUS MOBILITY: IS OUR ROAD NETWORK READY?

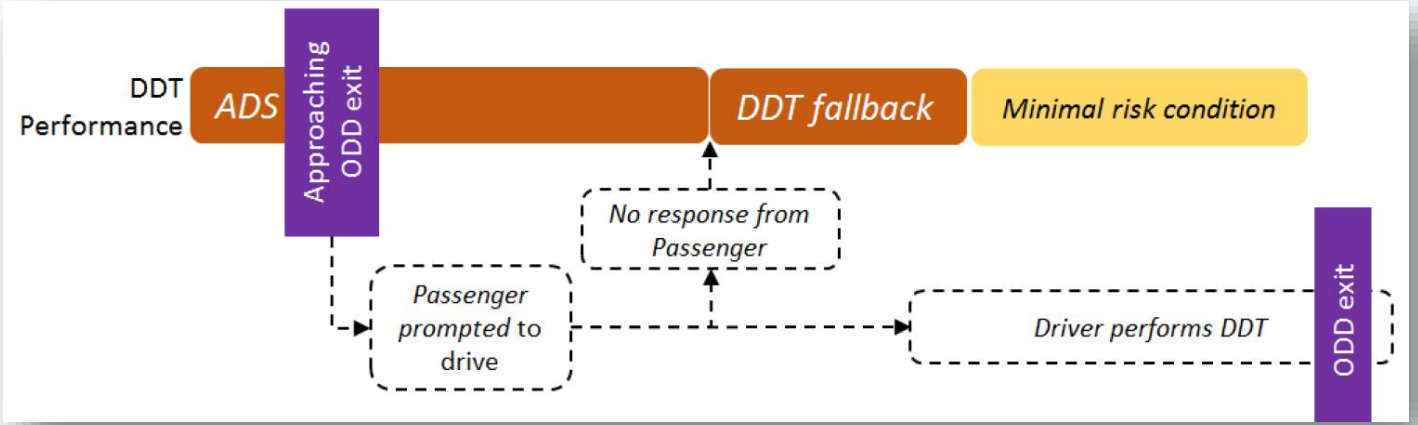
DR. JAAP VREESWIJK

TRAFFIC ARCHITECT CONNECTED & AUTOMATED DRIVING

MAP TRAFFIC MANAGEMENT, THE NETHERLANDS

OPERATIONAL DESIGN DOMAIN > TRANSITION AREAS

*ODD is a description of the specific operating conditions in which the automated driving system is **designed to properly operate**, including but not limited to roadway types, speed range, environmental conditions (including weather, daytime/night-time), prevailing traffic laws and regulations, and other domain constraints .*



SAE, Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems J3016_201401

WHEN, WHERE, WHY?

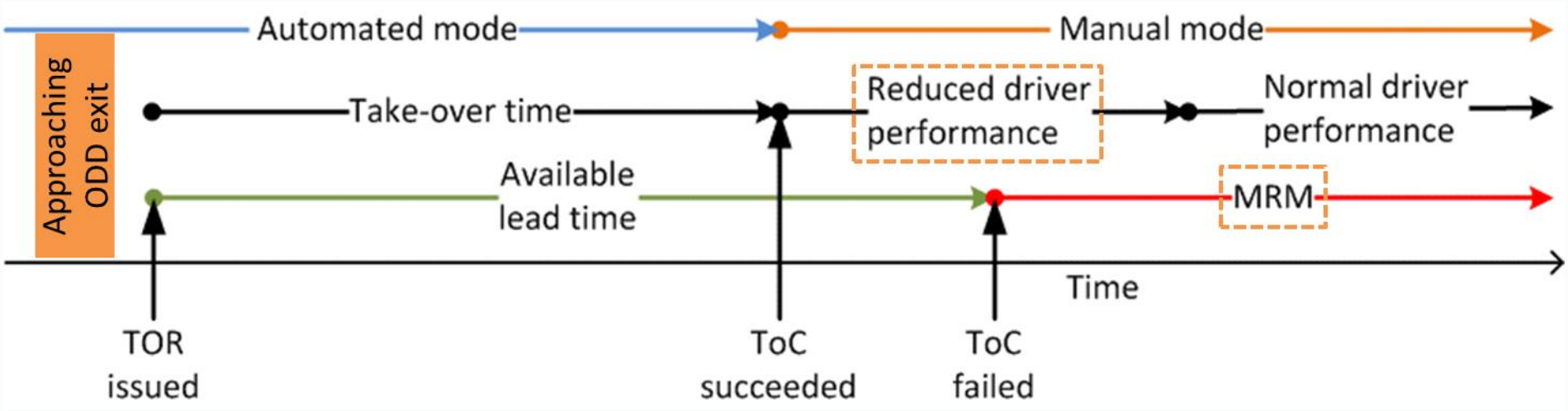
PERMANENT - TRANSIENT STATIC/DYNAMIC - HIGHLY DYNAMIC

DEPARTMENT OF TRANSPORT

PIARC

UNITED ARAB EMIRATES
MINISTRY OF INFRASTRUCTURE DEVELOPMENT

TRANSITION OF CONTROL (TOC) TIMELINE



Minimum Risk Manoevre (MRM),
minimum risk condition = stop or park safely.

WHY TRANSITION AREAS?

Transition areas mark the boundaries of the ODD.

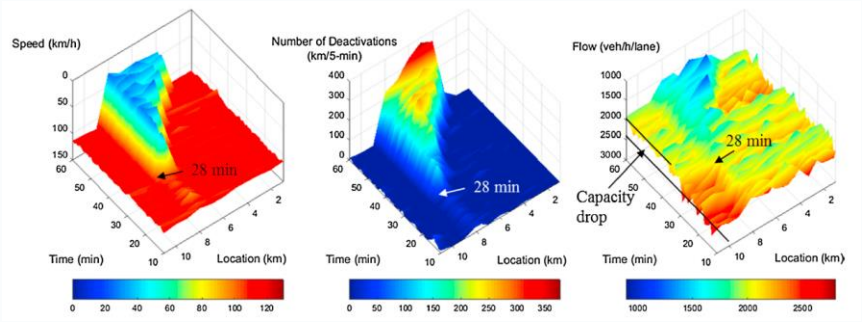
What if an automated vehicle is unable to solve the situation ahead?

- …what if, this happens not to single vehicles only, but to several?
- …what if, it always happens on the same spot?
- …what if, this interrupts traffic flow, traffic safety, etc.

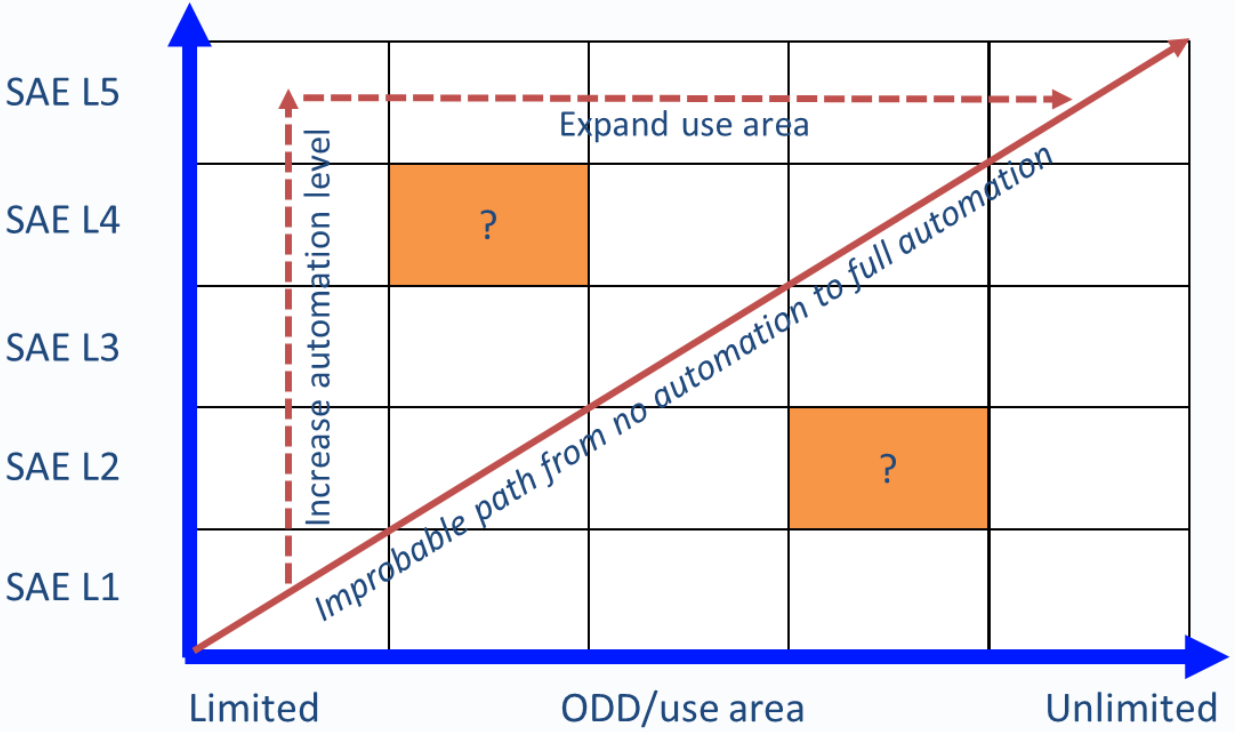
Xiao, L., et al.(2018). Transportation Research Part C: Emerging Technologies, 96, 380-397.

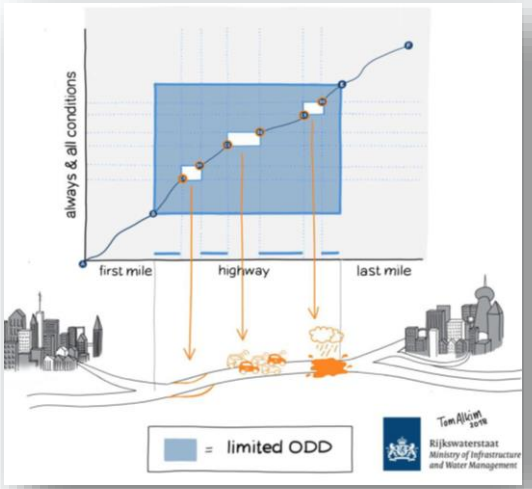
TransAID aims to:

- Identify potential risks
- Recommend solutions
- Coordinate movements with V2X

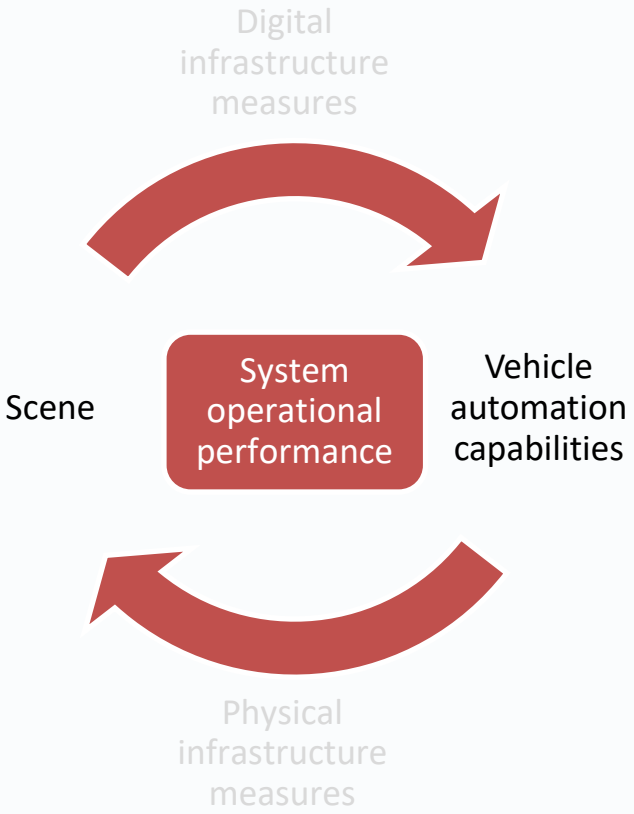


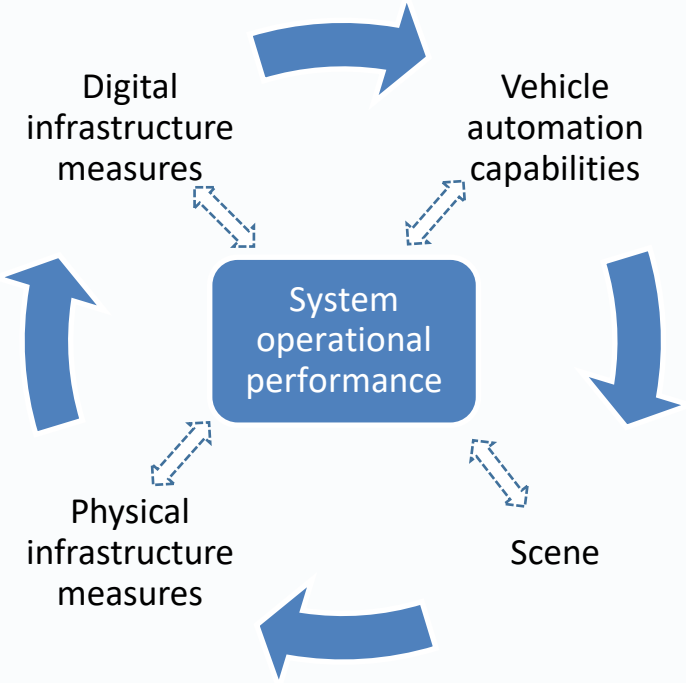
THE GEOGRAPHICAL DIMENSION OF ODD (?)





STRIA Roadmap for Connected and Automated Transport (2019 update)


Digital infrastructure measures
Scene
System operational performance
Vehicle automation capabilities
Physical infrastructure measures


Digital infrastructure measures
Vehicle automation capabilities
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Scene

VEHICLE AUTOMATION CAPABILITY SAE 1-5

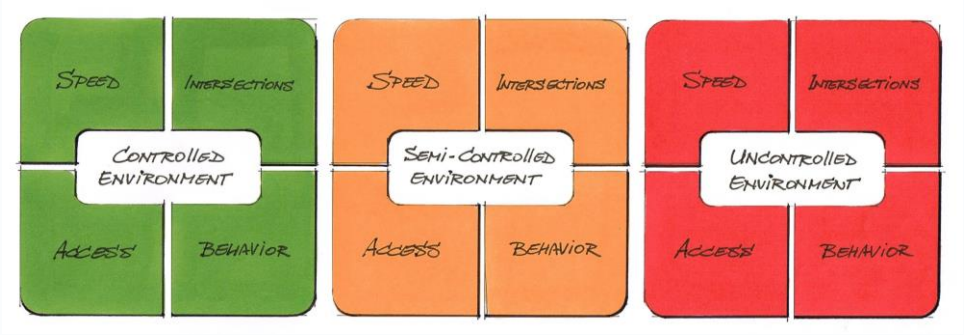
- No automation (0)
- Driver assistance (1)
- Partial automation (2)
- Conditional automation (3)
- High automation (4)
- Full automation (5)

Vehicle automation capabilities

SAE, Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems J3016_201401

SCENE (INCL. TRAFFIC DYNAMIC & SITUATIONAL FACTORS)

- Intersections (cross traffic yes or no)
- Access (restricted, shared, open)
- Behaviour (homogeneous or heterogenous, thereby predictable)
- Traffic volume
- Weather conditions



Scene

https://www.2getthere.eu/autonomous-transit-a-reality/

PHYSICAL INFRASTRUCTURE MEASURES

- Road surface
- Shoulder or kerb
- Road markings
- Traffic signs
- Road furniture

Physical infrastructure measures

DIGITAL INFRASTRUCTURE SUPPORT LEVELS E-A

- Conventional (E)
- Static digital information (D)
- Dynamic digital information (C)
- Cooperative perception (B)
- Cooperative driving (A)

Digital infrastructure measures

	Level	Name	Description	Digital information provided to AVs			
				Digital map with static road signs	VMS, warnings, incidents, weather	Microscopic traffic situation	Guidance: speed, gap, lane advice
Digital infrastructure	A	Cooperative driving	Based on the real-time information on vehicles movements, he infrastructure is able to guide AVs (groups of vehicles or single vehicles) in order to optimize the overall traffic flow	X	X	X	X
	B	Cooperative perception	Infrastructure is capable of perceiving microscopic traffic situations and providing this data to AVs in real-time	X	X	X	
	C	Dynamic digital information	All dynamic and static infrastructure information is available in digital form and can be provided to AVs	X	X		
Conventional infrastructure	D	Static digital information / Map support	Digital map data is available with static road signs. Map data could be complemented by physical reference points (landmarks signs). Traffic lights, short term road works and VMS need to be recognized by AVs	X			
	E	Conventional infrastructure / no AV support	Conventional infrastructure without digital information. AVs need to recognise road geometry and road signs				

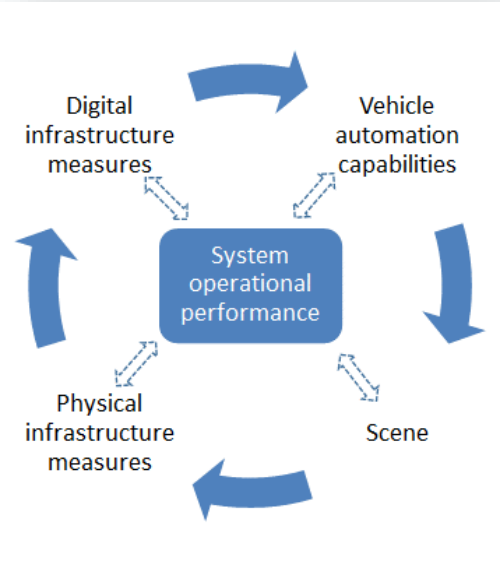
https://www.inframix.eu/infrastructure-categorization/

SYSTEM (OR VEHICLE) OPERATIONAL PERFORMANCE

- Vehicle safety
- Travelling comfort
- Driving speed (and travel time)
- Number of stop Stops
- Number of handovers of control
- Number of minimum risk manoeuvres

Ex-post as a consequence of the state-of-the-art.
Ex-ante performance requirements are a necessity!

ODD AND TRANSITION AREA CONTROL AS A HOLISTIC CONCEPT



Vehicle automation capability SAE 1-5

- No automation (0), driver assistance (1) partial automation (2), conditional automation (3), high automation (4), full automation (5)

Scene (incl. traffic dynamic & situational factors)

- Intersections (cross traffic yes or no), access (restricted, shared, open), behaviour (homogeneous or heterogenous, thereby predictable)

Physical infrastructure measures

- Road surface, shoulder or kerb, road markings, traffic signs, road furniture

Digital infrastructure support levels E-A

- Conventional (E), static digital information (D), dynamic digital information (C), cooperative perception (B), cooperative driving (A)

System operational performance

- Vehicle safety, travelling comfort, driving speed, stops, number of handovers of control and minimum risk manoeuvre

THE TRANSAID REASONING FOR I2V SUPPORT

Vehicle automation capabilities (A)

+

Scene (B)

=

ODD

A = B ODD: OK

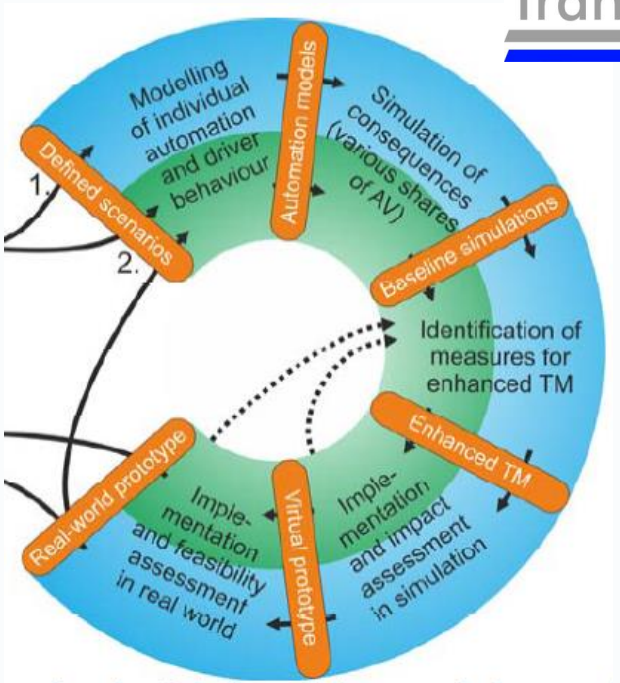
A ≠ B ODD: NOK

A + ? = B ODD: OK?

? = digital infrastructure measures

TRANSAID PROJECT OVERVIEW

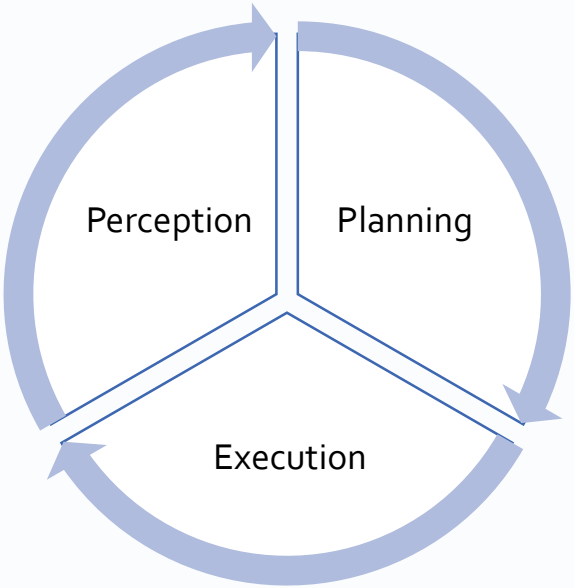
- TransAID (ART-05)
- Transition Areas for Infrastructure-Assisted Driving
- 01-09-2017 ~ 31-08-2020
- Budget: EUR 3.836.353,75
- Seven partners from 6 countries: DE, UK, BE, NL, EL, ES
- Website: www.transaid.eu



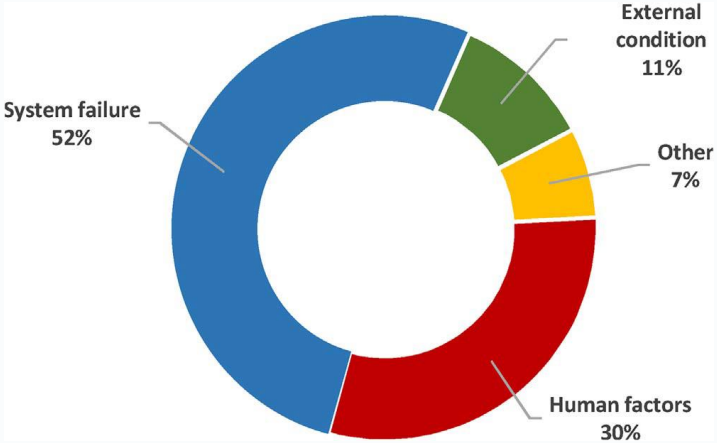
IDENTIFYING I2V / TM SUPPORT MEASURES

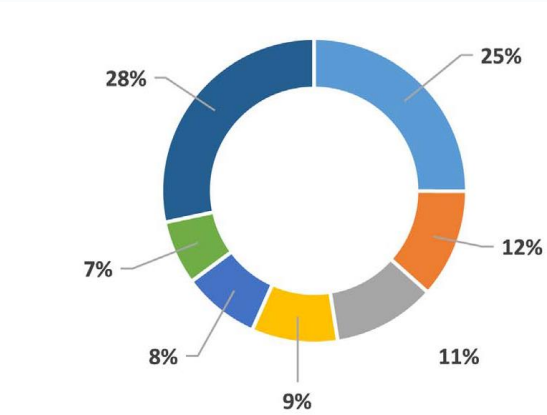
TO COMPLEMENT VEHICLE AUTOMATION SYSTEMS

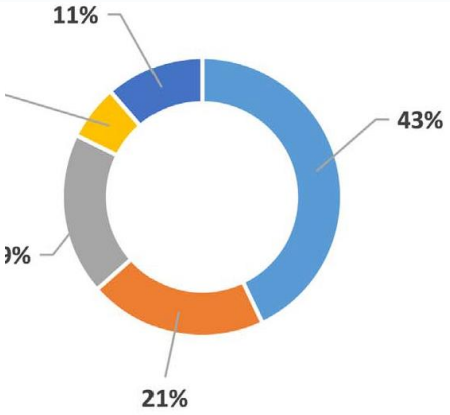
- Sense and build environmental awareness
  - Situational support: provide relevant information
- Ability to determine action(s)
  - Operational support: provide an (alternative) action
- Ability to perform action(s)
  - Tactical support: arrange favourable conditions



ODD/DISENGAGEMENT REPORTS FROM THE FIELD







- software discrepancy
- perception discrepency
- planner not ready
- traffic light detection
- lane change
- unwanted maneuver of vehicle
- Other System Failure factors*

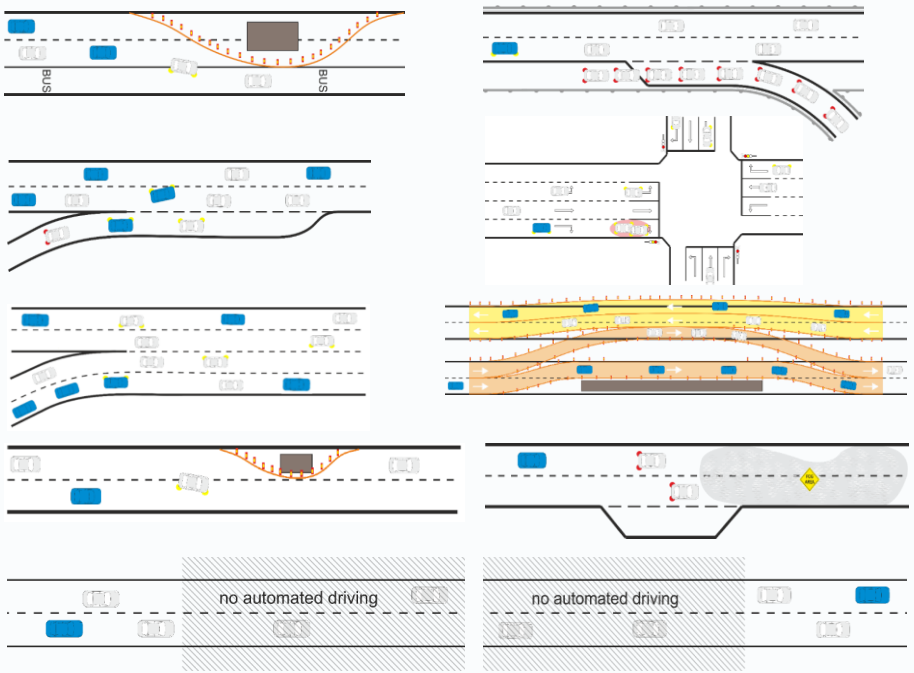
- poorly marked lanes
- construction zone
- heavy pedestrian traffic
- weather condition
- other external condition factors**

Favaro et al. (2017), Autonomous vehicles' disengagements: Trends, triggers, and regulatory limitations, Accident Analysis & Prevention, Vol. 110, pp. 136-148

TRANSAID I2V SERVICES AND USE CASES

TO PREVENT OR MANAGE TOC/MRM

1. Provide vehicle path information
2. Provide speed, headway and/or lane advice
3. Traffic separation
4. Guidance to safe spot
5. Orchestration, distribution and scheduling



TRANSAID AREAS OF RECOMMENDATION

Information services for automated vehicles.

Traffic control measures for automated driving.

Traffic regulations for automated driving.

Spatial planning for automated driving, MRM-havens specifically.

Application of **V2X message sets** and proposed extensions.

Requirements for **roadside equipment and signalling,** for all vehicle modes.

Urgency of interventions based on market penetration (mixed traffic) forecasts.

Priority of interventions based on situational characteristics.

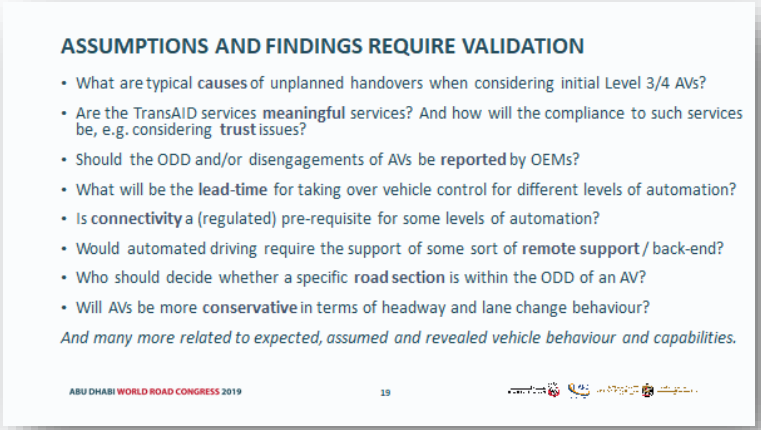
Actor **roles and interaction models** for automated driving and traffic management.

www.transaid.eu
@transaid_h2020
www.linkedin.com/groups/13562830/
www.facebook.com/transaidh2020/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723390

MAP TRAFFIC MANAGEMENT

TransAID



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