



Infrastructure-Assisted Management for Mixed Traffic at Transition Areas

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TRAFFIC MANAGEMENT

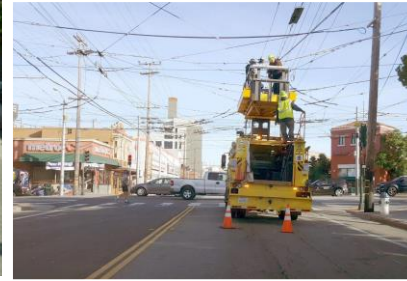
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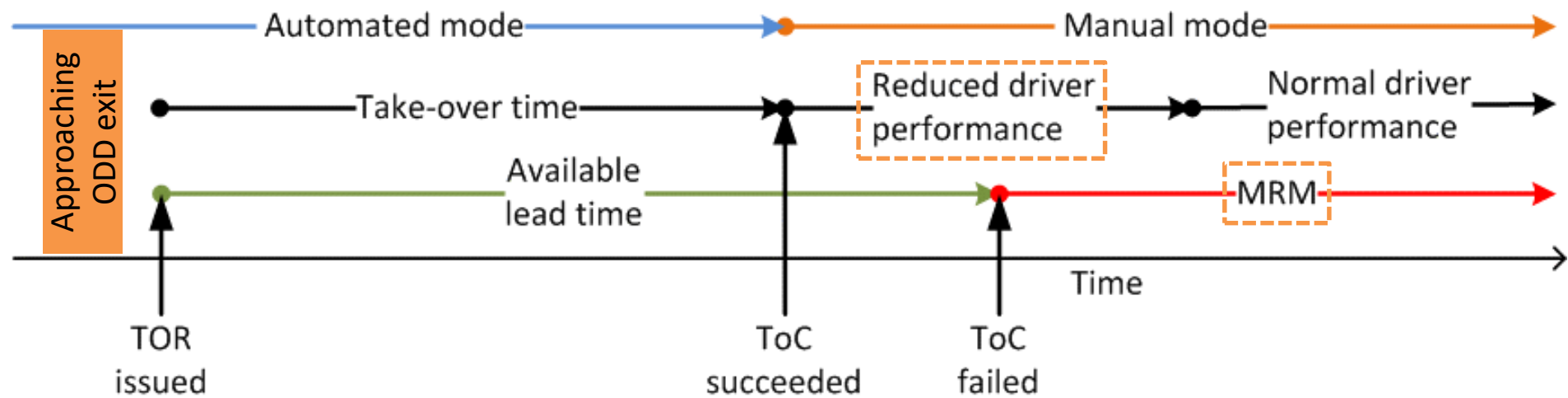


When, where, why?

permanent - transient
static/dynamic - highly dynamic



Transition of control and ODD



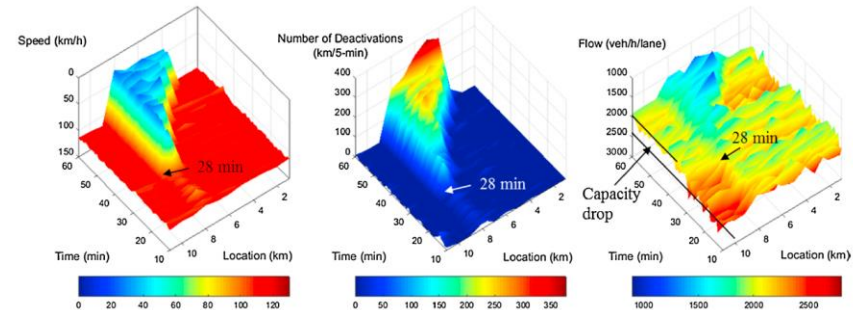
MRM minimum risk condition = stop or park safely.

Why transition areas?

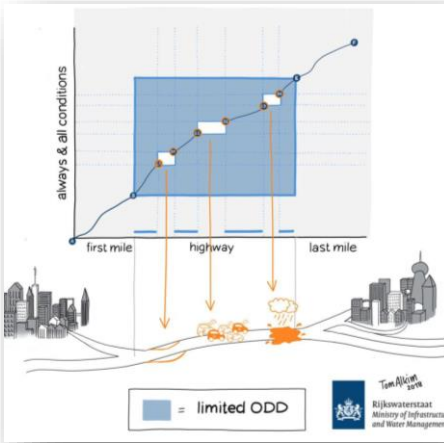
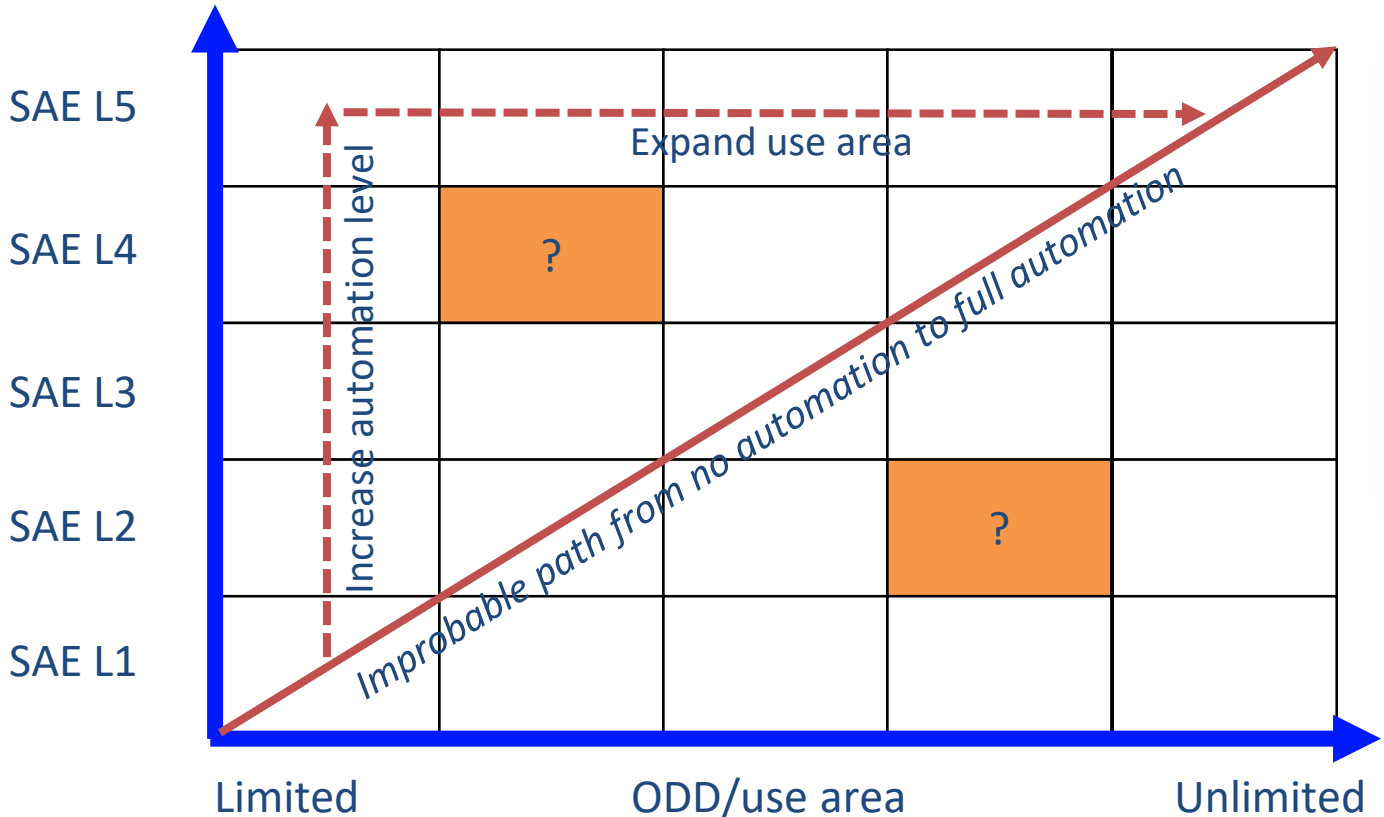
- ❑ Transition areas mark the boundaries of the ODD.
- ❑ What if an automated vehicle is unable to solve the situation ahead?
 - ✓ ...what if, this happens not to single vehicles only, but to several?
 - ✓ ...what if, it always happens on the same spot?
 - ✓ ...what if, this interrupts traffic flow, traffic safety, etc.

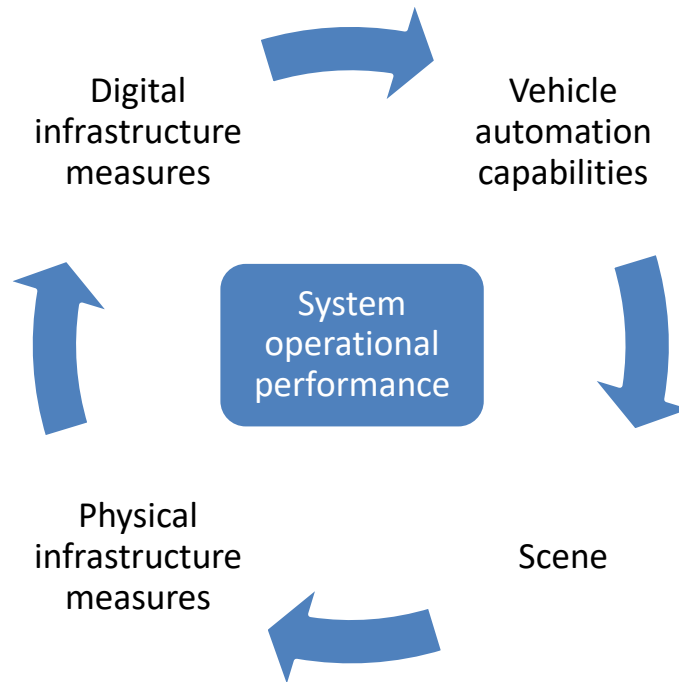
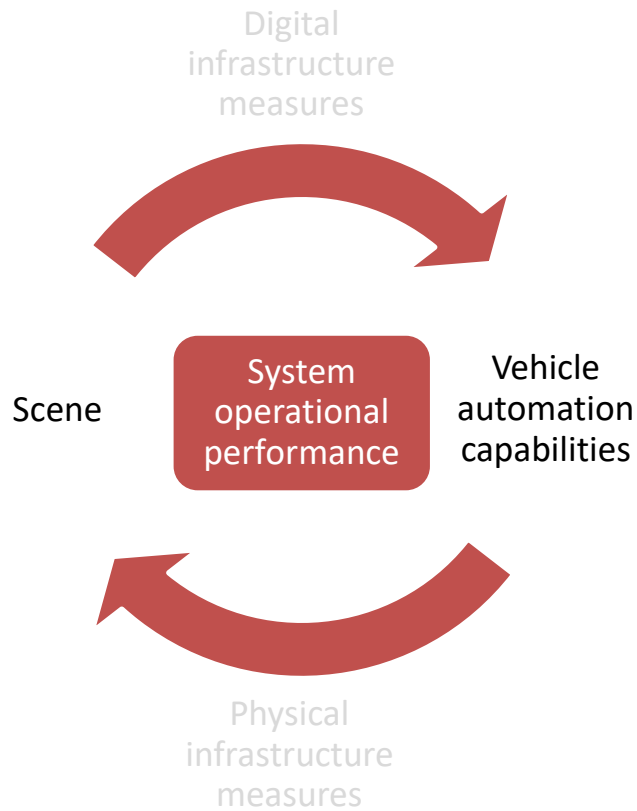
- ❑ TransAID aims to:
 - ✓ Identify potential risks
 - ✓ Recommend solutions
 - ✓ Coordinate movements

Xiao, L. et al. (2018)

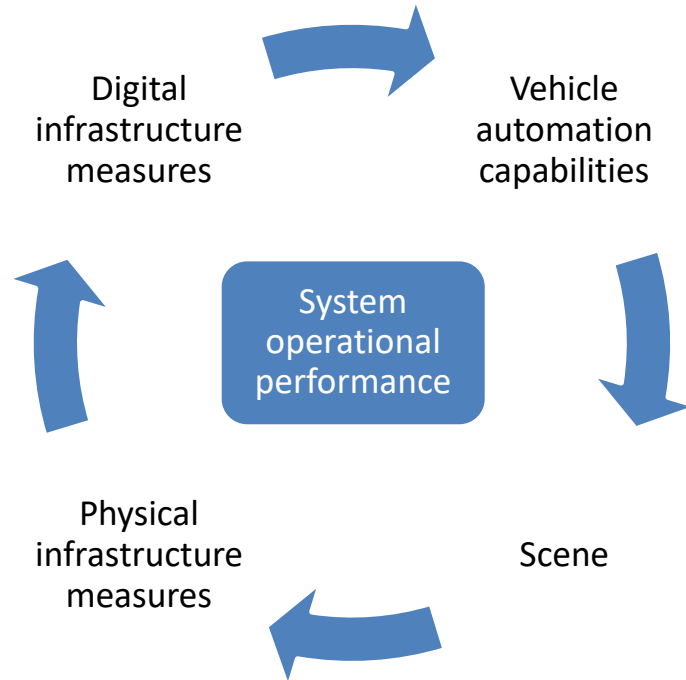


A geographical representation of ODD





ODD 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
 - 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)
x
Scene (B)
x
Traffic dynamics &
situational variables (C)
=
ODD

$B + C = A$ ODD: OK

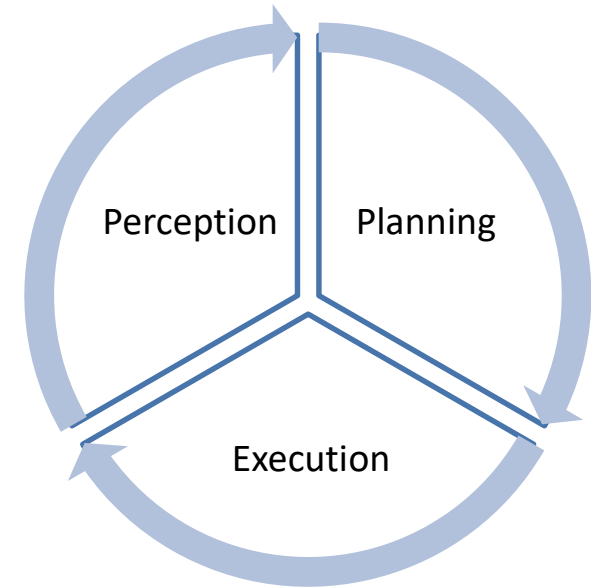
$B + C \neq A$ ODD: NOK

$B + C = A + ?$ ODD: OK?

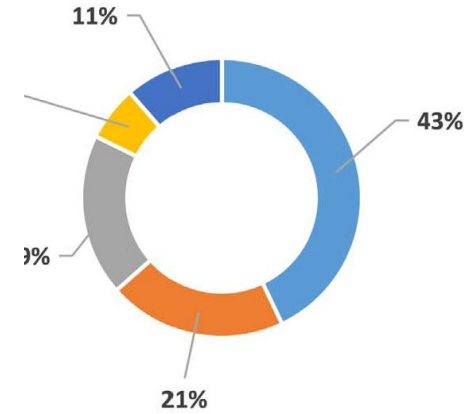
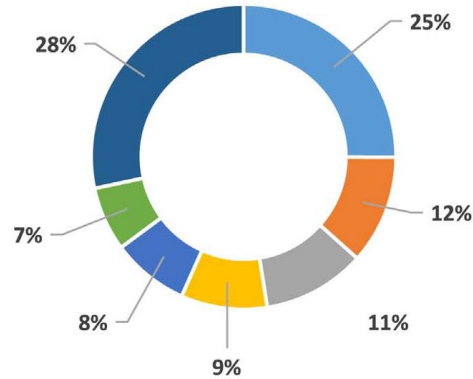
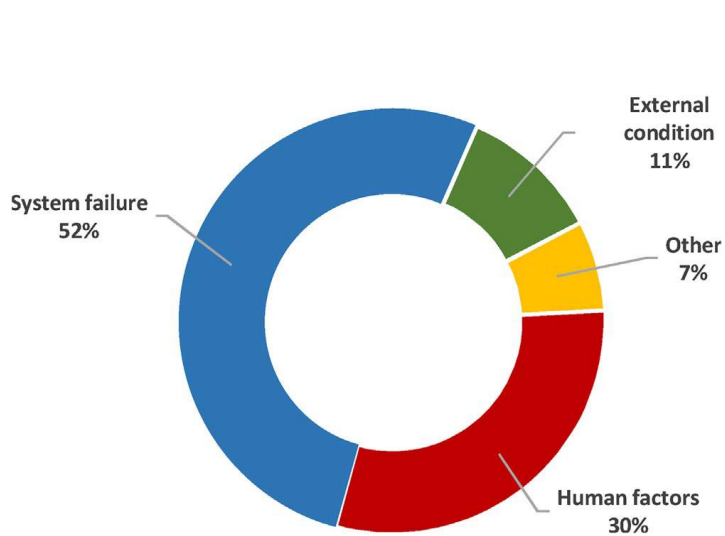
? = digital infra measures

Identifying I2V / TM support measures

- 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



Report from the field

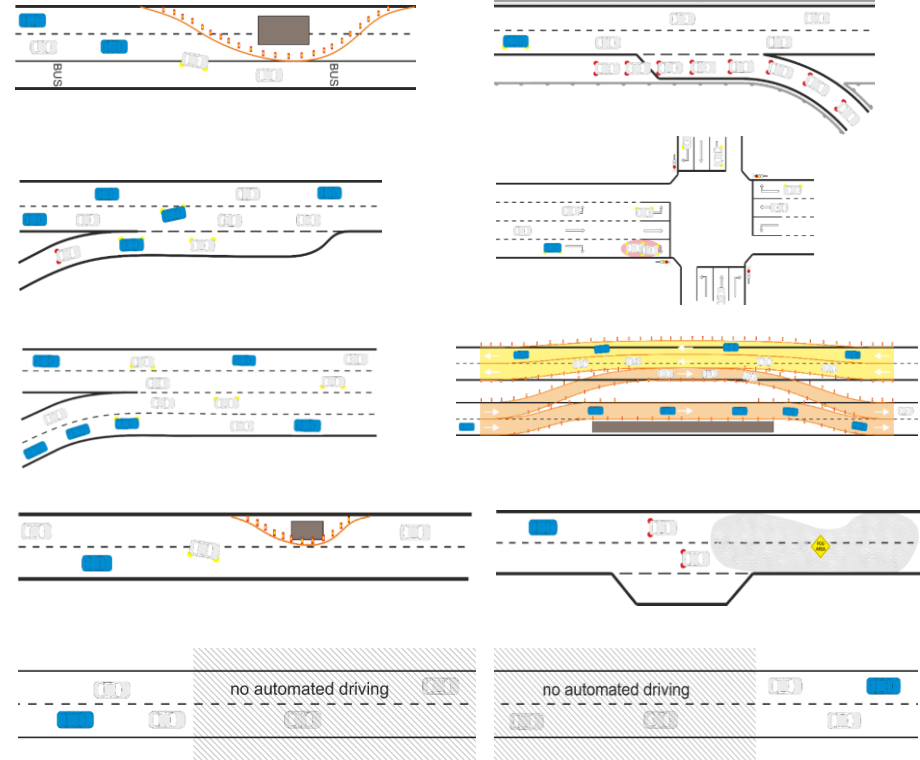


- software discrepancy
- perception discrepancy
- planner not ready
- traffic light detection
- lane change
- unwanted maneuver of vehicle
- Other System Failure factors*
- poorly marked lanes
- construction zone
- heavy pedestrian traffic
- weather condition
- other external condition factors**

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

TransAID services and use cases

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.

Questions

- What are typical **causes** of unplanned handovers when considering initial Level 3/4 AVs?
- Are the TransAID services **meaningful** services? And how will the compliance to such services be, e.g. considering **trust** issues?
- Should the ODD and/or disengagements of AVs be **reported** by OEMs?
- What will be the **lead-time** for taking over vehicle control for different levels of automation?
- Is **connectivity** a (regulated) pre-requisite for some levels of automation?
- Would automated driving require the support of some sort of **remote support** / back-end?
- Who should decide whether a specific **road section** is within the ODD of an AV?
- Will AVs be more **conservative** in terms of headway and lane change behaviour?

And many more related to expected, assumed and revealed vehicle behaviour and capabilities.



Thank you for listening!

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