Digital infrastructure to support automated driving at transition areas

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Dr. Jaap Vreeswijk
MAP traffic management, the Netherlands

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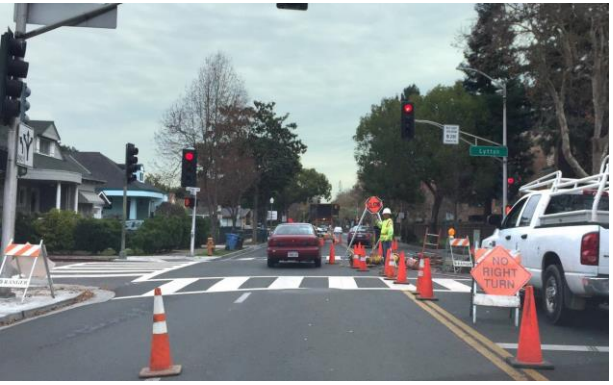
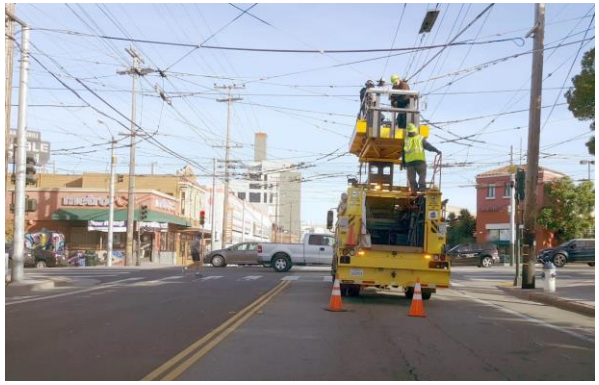
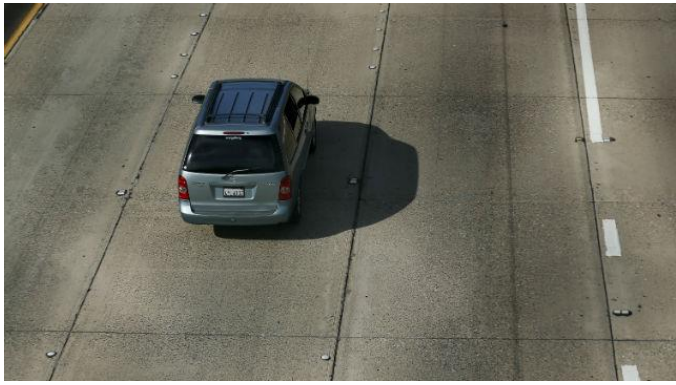
What if…

- …your CAV is not able to solve the situation ahead?







Situation not understood (e.g. irregular or complexity)

Required action not allowed (e.g. rules)

Required action not possible (e.g. safety margin)

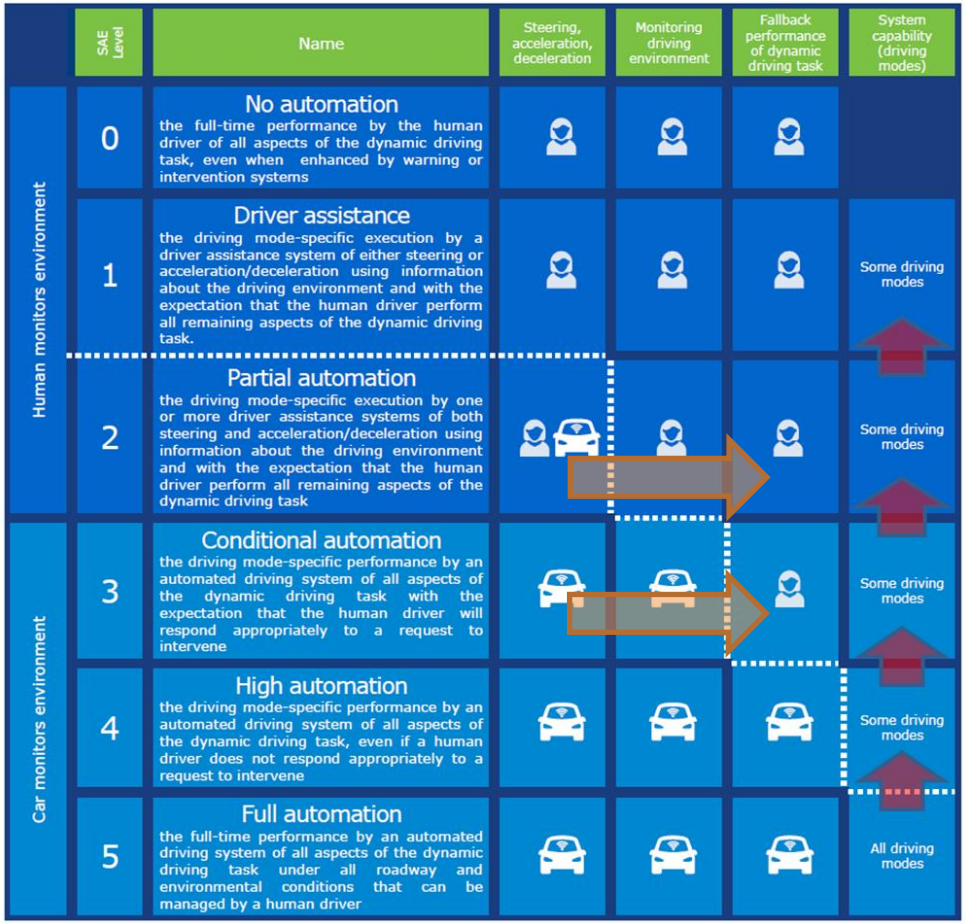
Hardware or software limitation or failure (e.g. not mapped, sensor input, poor localisation)

Transition of control

- Return (full) control to the driver
  - *Perform minimum risk manoeuvre (e.g. stop)*

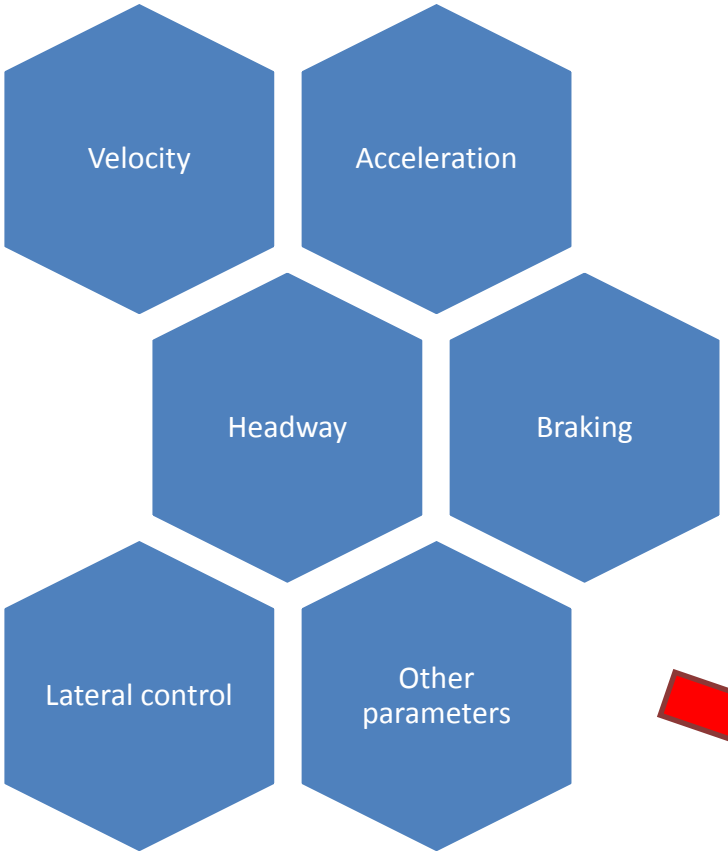
Transition of driving mode

- Degrade level of automation to ‘safer’ driving mode
- Thereby, (partically) return control to the driver?

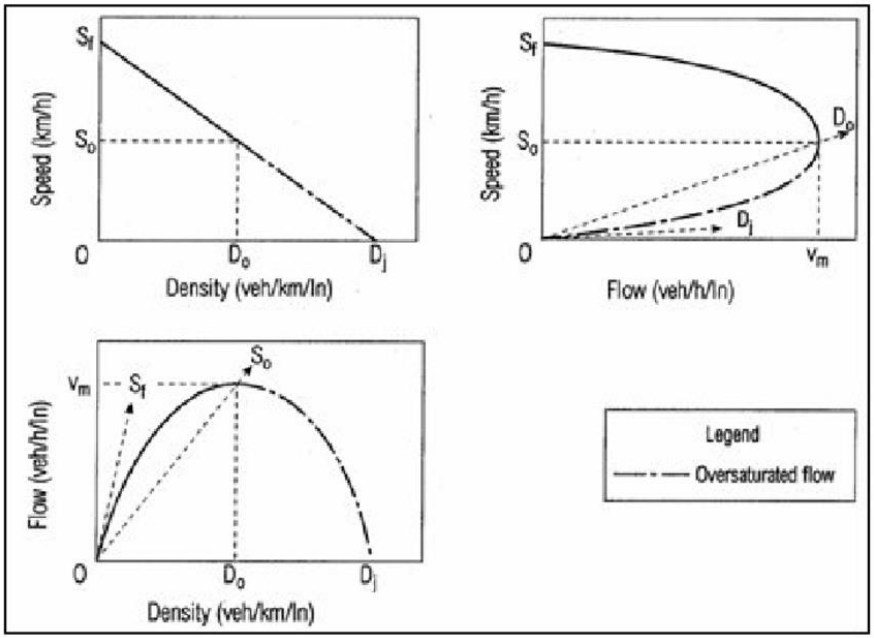


Type of impact

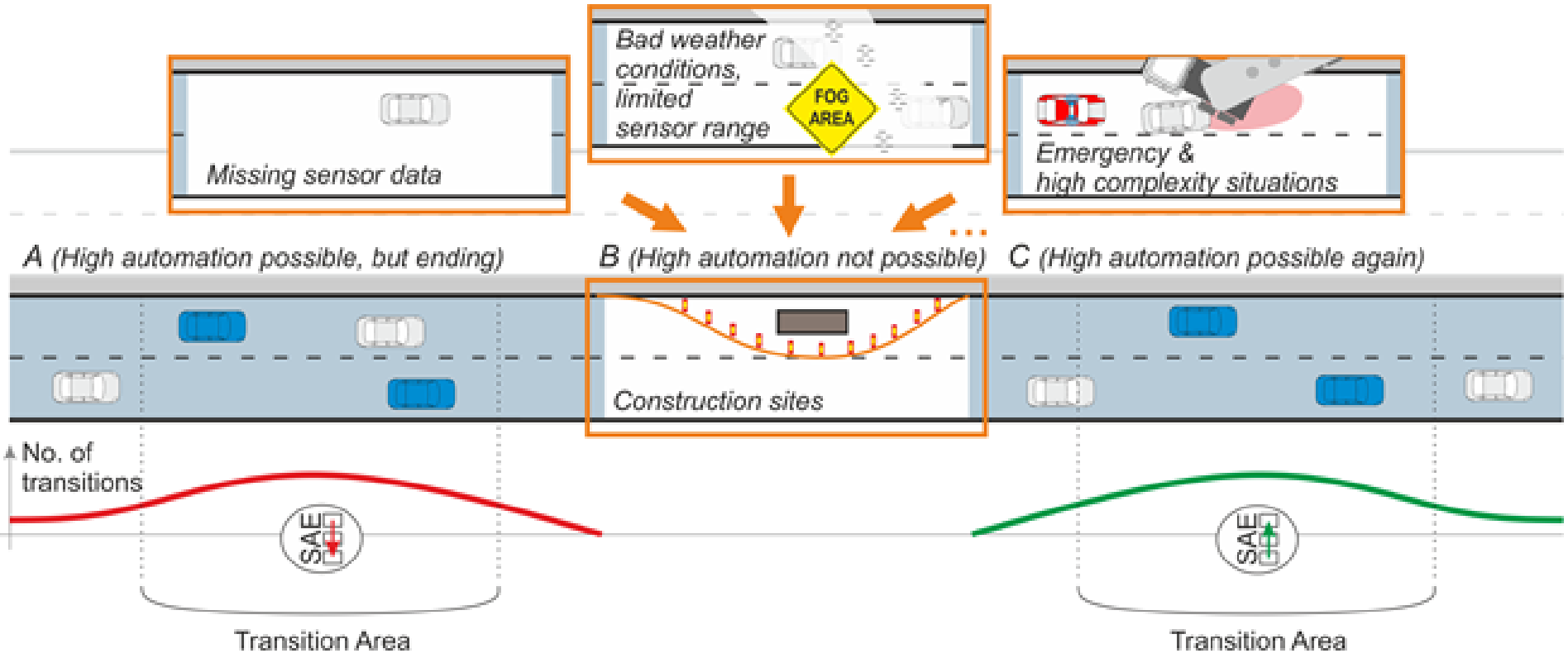
Driving behaviour



Traffic flow dynamics

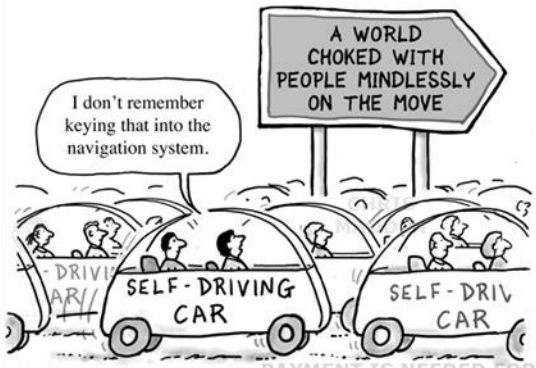


Surrogate safety indicators, therefore traffic safety

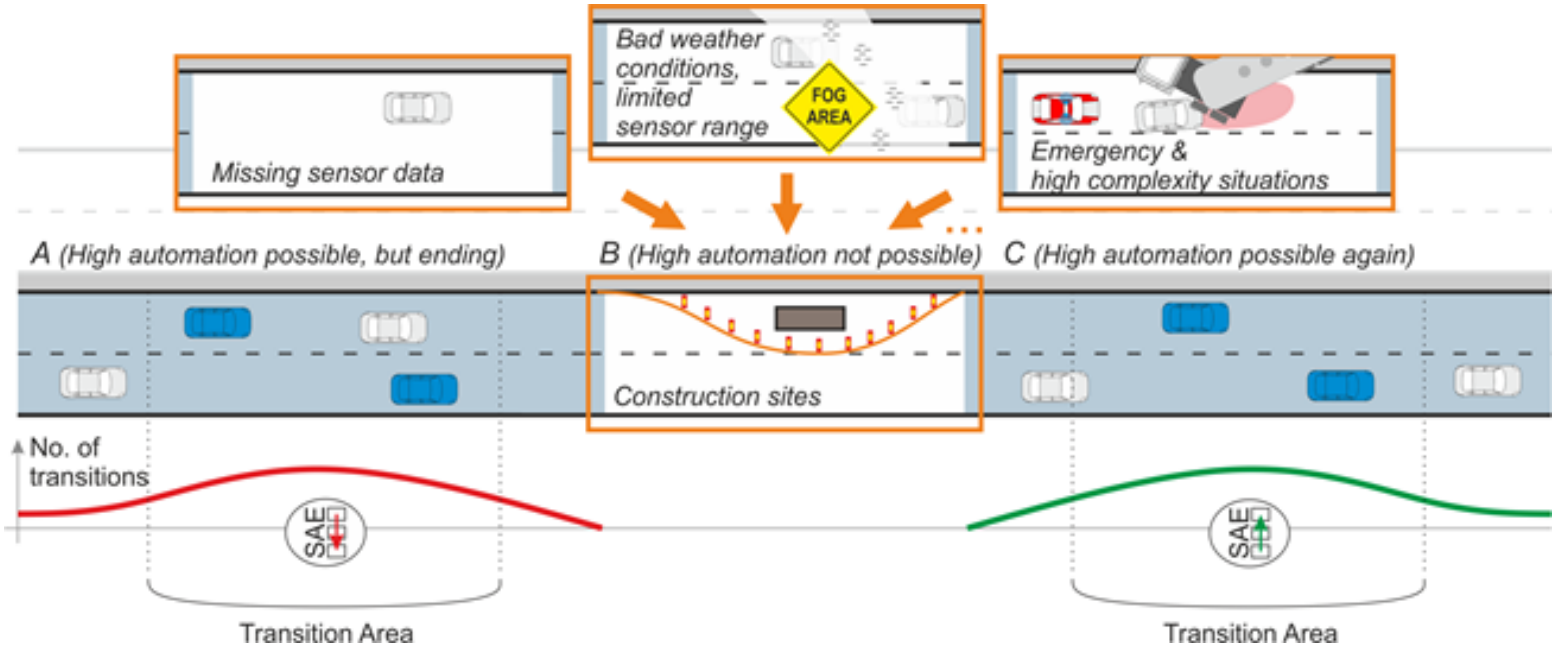

Missing sensor data
Bad weather conditions, limited sensor range
FOG AREA
Emergency & high complexity situations
A (High automation possible, but ending)
B (High automation not possible)
C (High automation possible again)
Construction sites
No. of transitions
SAE
SAE
Transition Area
Transition Area

What if…

- …your automated vehicle is not able to solve the situation ahead?



- …this happens not to single vehicles only, but to several?
- …it always happens on the same location?
- …in mixed traffic fleets?



Scenario Area (bottleneck)

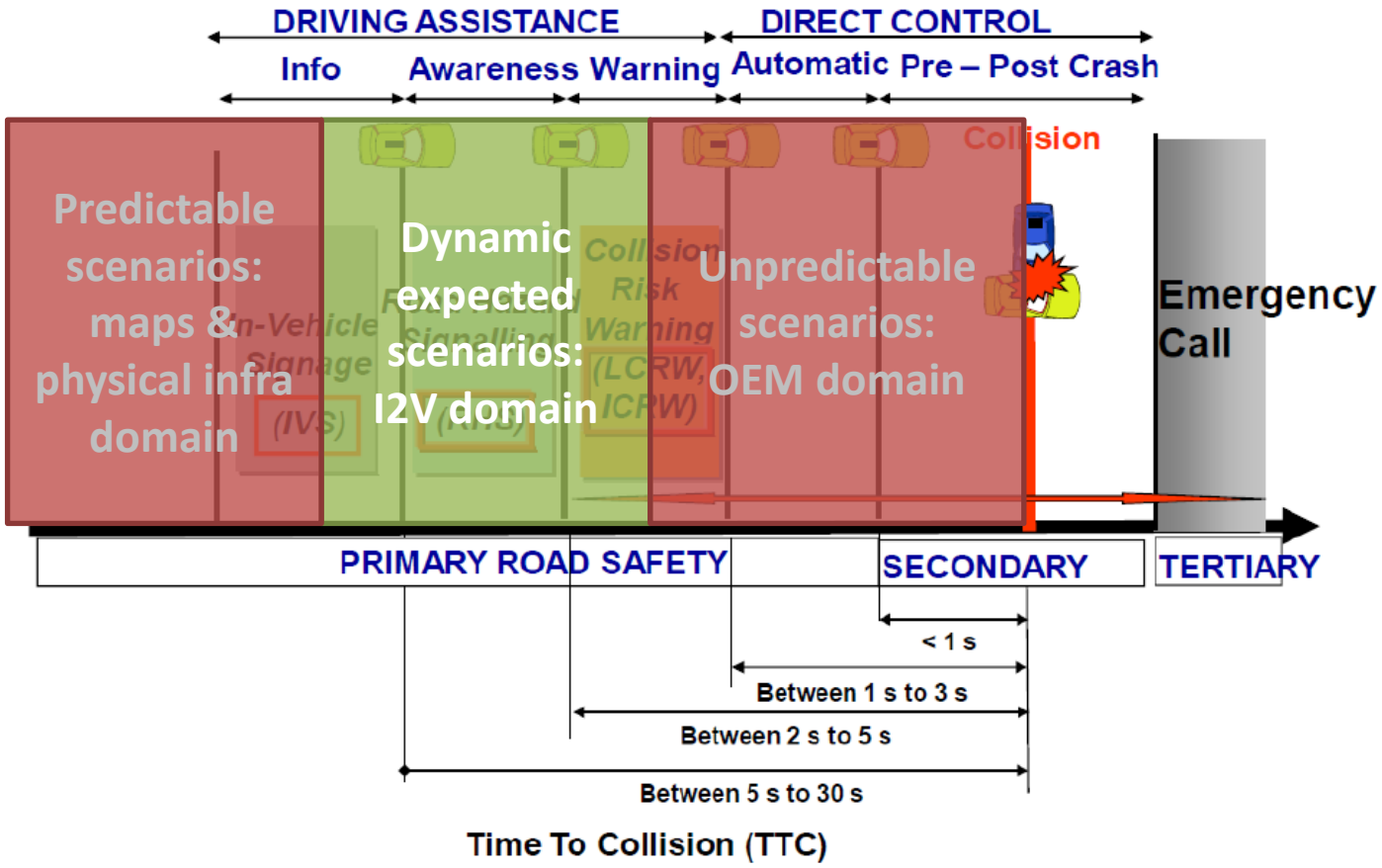
Transition Area (impact area)

Transition Area

Infrastructure-assistance (mitigation area)

Infrastructure-assistance

Focus


DRIVING ASSISTANCE
DIRECT CONTROL
Info
Awareness Warning
Automatic Pre – Post Crash
Predictable scenarios: maps & physical infra domain
Dynamic expected scenarios: I2V domain
Unpredictable scenarios: OEM domain
Collision
Emergency Call
PRIMARY ROAD SAFETY
SECONDARY
TERTIARY
< 1 s
Between 1 s to 3 s
Between 2 s to 5 s
Between 5 s to 30 s
Time To Collision (TTC)

Possible measures - targets

Add digital infrastructure (I2V support) to even / compensate dynamics in operational design domain:

- Avoid transition (maintain automation level)
- Timing of transition (in time and/or space)
- Smoothen transition (better HMI)

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.

…

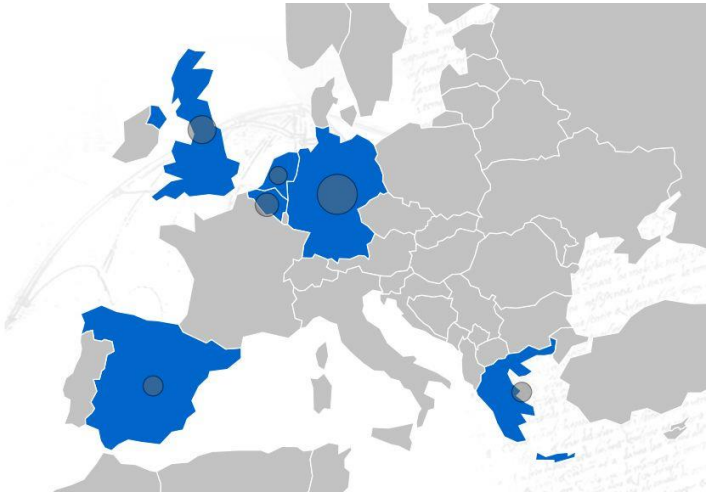
Required forms of visual and **electronic signalling and optical guidance**, ensuring readability by both automated and conventional vehicles, and enabling automated driving in also adverse road weather conditions.

…

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.

TransAID

- 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



Objective and approach

Develop and demonstrate **infrastructure-assisted** traffic management procedures and protocols for smooth **coexistence** between automated, connected, and conventional vehicles especially at **Transition Areas** in an **urban** environment.

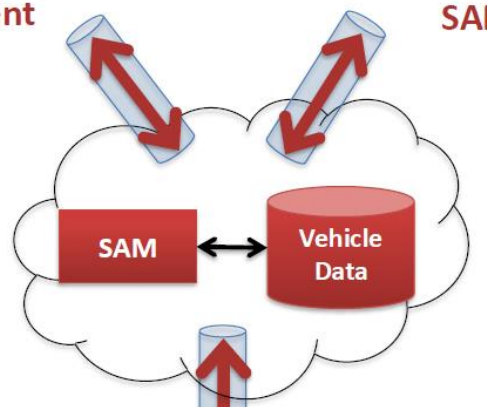
SAM

Developed from
NASA Technology

NISSAN

SAM Fleet Management

SAM VR Teleoperation



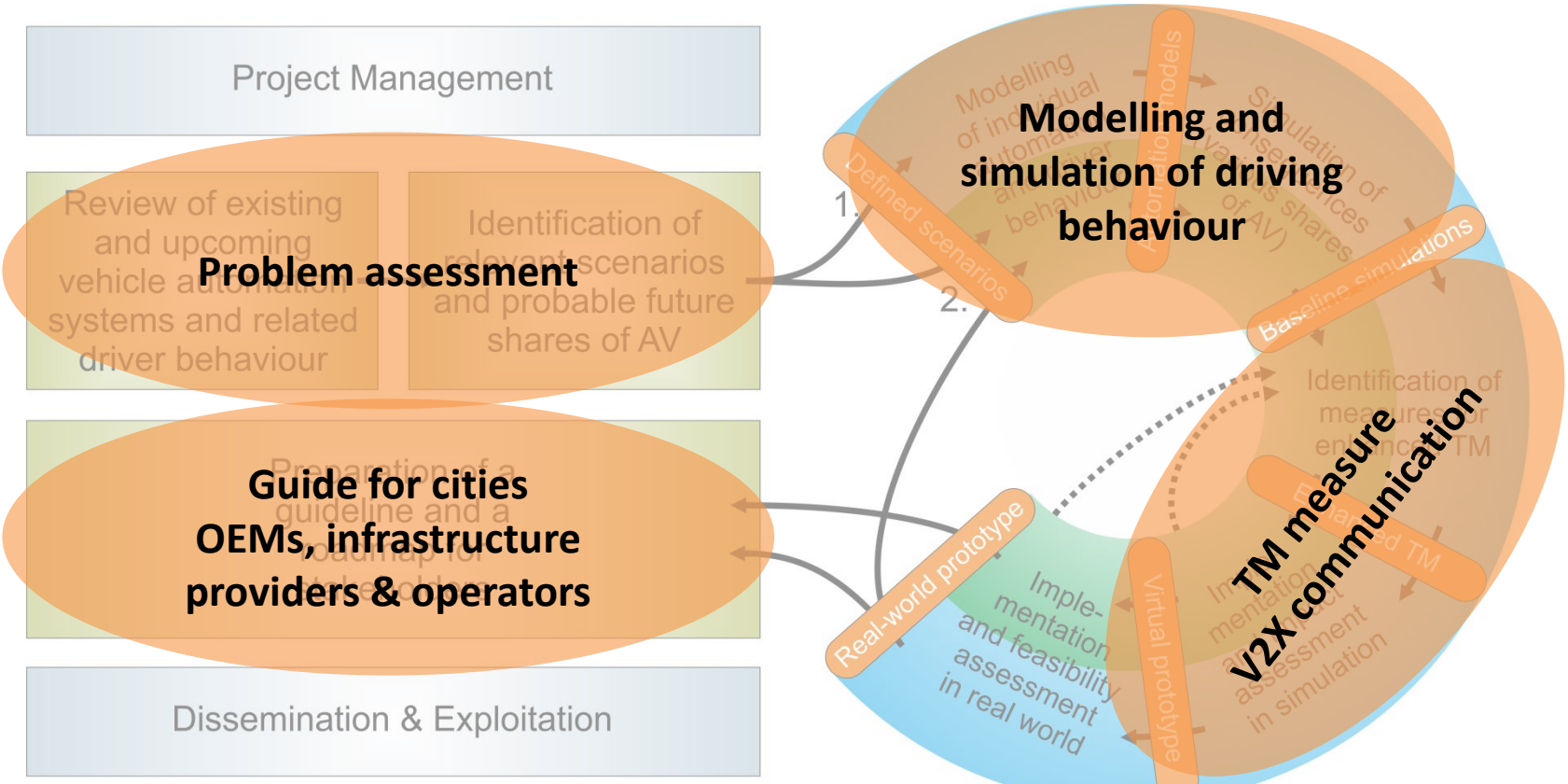
SAM CLOUD

SAM AV

4G Mobile Com

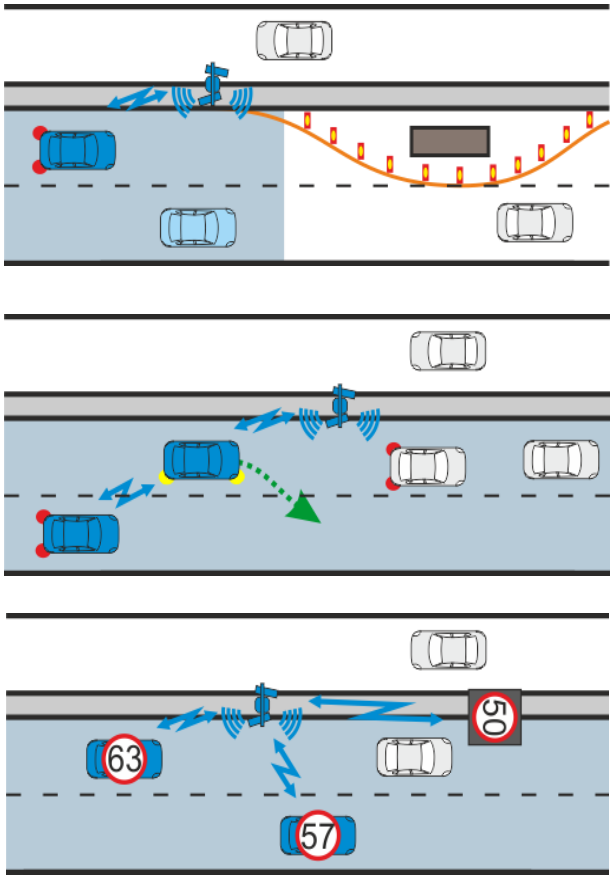
SAM AV

Approach (2x)


Project Management
Review of existing and upcoming vehicle automation systems and related driver behaviour
Identification of relevant scenarios and probable future shares of AV
Problem assessment
Guide for cities OEMs, infrastructure providers & operators
Dissemination & Exploitation
Modelling and simulation of driving behaviour
Defined scenarios
Baseline simulations
Real-world prototype
Virtual prototype
Imple-mentation and feasibility assessment in real world
TM measure V2X communication

Scenarios and measures

- **Scenarios**
  - Work zones
  - Merging sections / off-ramps
  - Incidents (accidents, occlusion, temporary)
  - Weather conditions
  - Emergency vehicle
  - Poor localisation
- **Measures**
  - Location and time of transition
  - Traffic separation
  - Lane advisory
  - Speed advisory / harmonisation
  - Trajectory information



A non-urban case: Truck Platooning

Exploration V2X extensions

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

- Infrastructure-to-Vehicle
  - Appropriate headway;
  - Maximum platoon length or platooning prohibition;
  - Feasible level of automated driving (road classification);

Questions – fact finding

- AV driving behaviour parameters in different SAE levels?
- Performance of (C)AV versus human drivers?
  - AV outperform humans (e.g. reaction time)
  - AV underperform humans (e.g. safety margin)
- Relevant scenarios (semi-dynamic)?

Dr. Jaap Vreeswijk

MAP traffic management

Email: jaap.vreeswijk@maptm.nl

Phone: +31 6 4164 7985

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