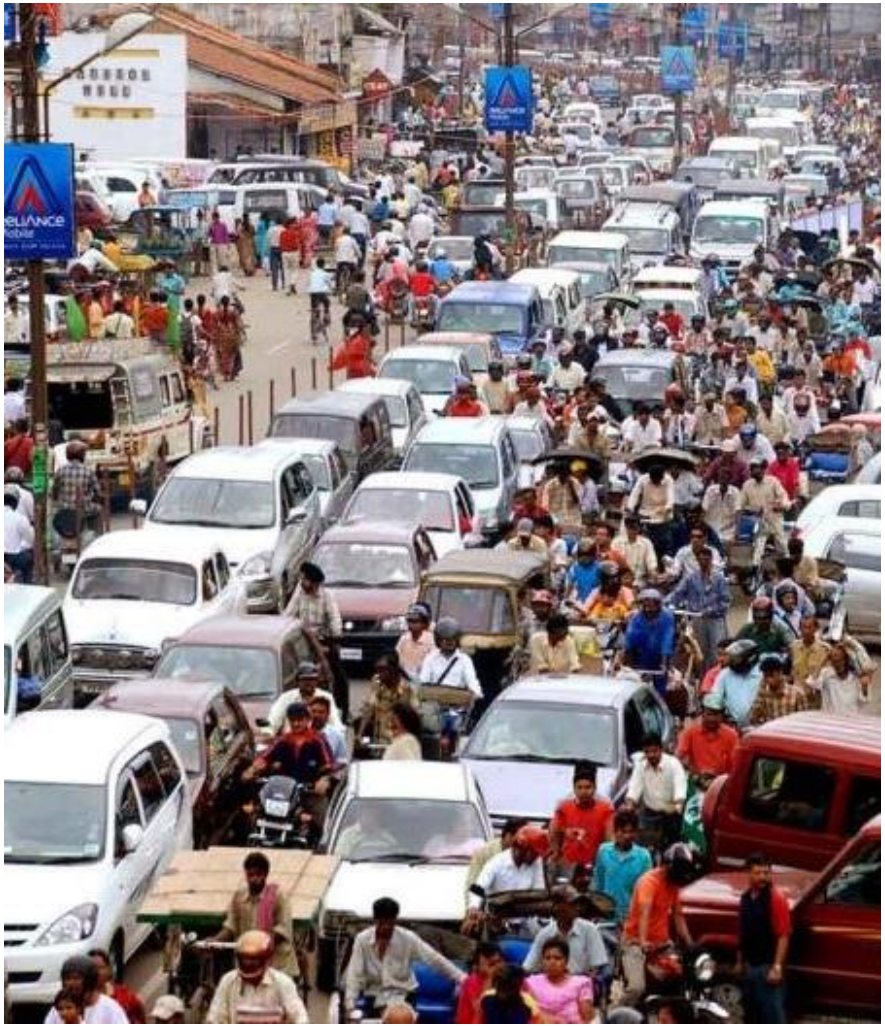
INFRAMIX – the Role of Infrastructure for a safe Arrival of CAD

SIS45 Safe & secure testing and operations

Martin Russ, AustriaTech



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1_Beyond SAE LEVELS

Towards Safe and Sustainable Mobility

4th High Level Meeting on Automated & Connected Mobility (Vienna 28/29 Nov 2018)

Common Questions

how **to learn from trials**

how to **enable capacity building**

how to **manage from a policy's perspective** and

how to enter an **active dialogue** with the industry

In Focus (1) – „Digital Infrastructure & Connectivity“

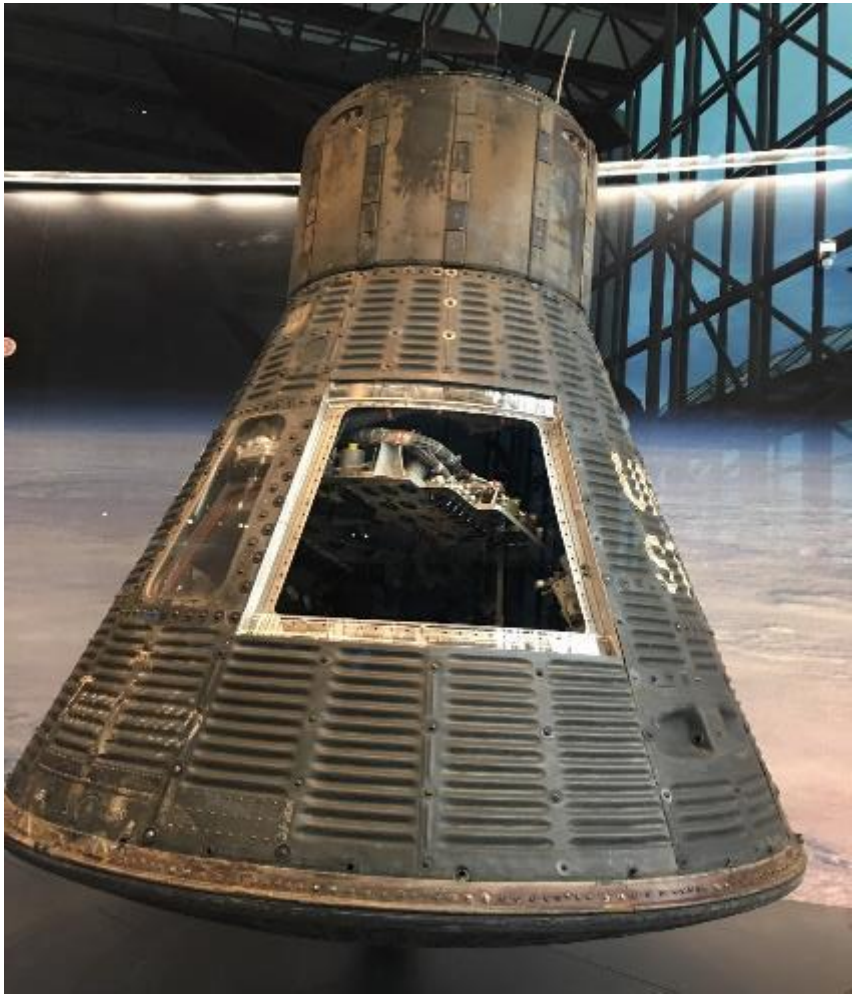
What?	How?
Common standards for operating CCAV	Definition of ODDs
Identification of infrastructure needs and classification of ODDs	Digital Repository of Roads
Ensure standardisation and interoperability for automated systems	Roadmap for Physical & digital Infrastructure

- *V2X Communication (ITS-G5 & Hybrid*
- *Update C-ITS Services with CCAD specific requirements (CAM, IVI, …)*
- *ODDs (Operational Design Domains) and ISAD (Infra Support Levels) are key*
- *„Adressed layers“ still unclear (SAE, functions, or „behavioural competences“ ?)*

In Focus (2) – Data & Reporting

What?	How?
Harmonised testing and comparable reports	Standards to be set Single European Platform
Open access to test data (for research and development purposes)	Obligations for testing companies & projects
Standards/obligations for safety reports (Failures, Disengagements)	UN-ECE, common methods and database

- *Comparability of Methods, Tests and Data –key for knowledge exchange*
- *Build upon existing references (e.g. FESTA Handbook)*
- *Data ≠ Data (Develop, Test, Validate, Operate)*
- *European approach for implementing, operating, recording, analysing, and comparing tests*



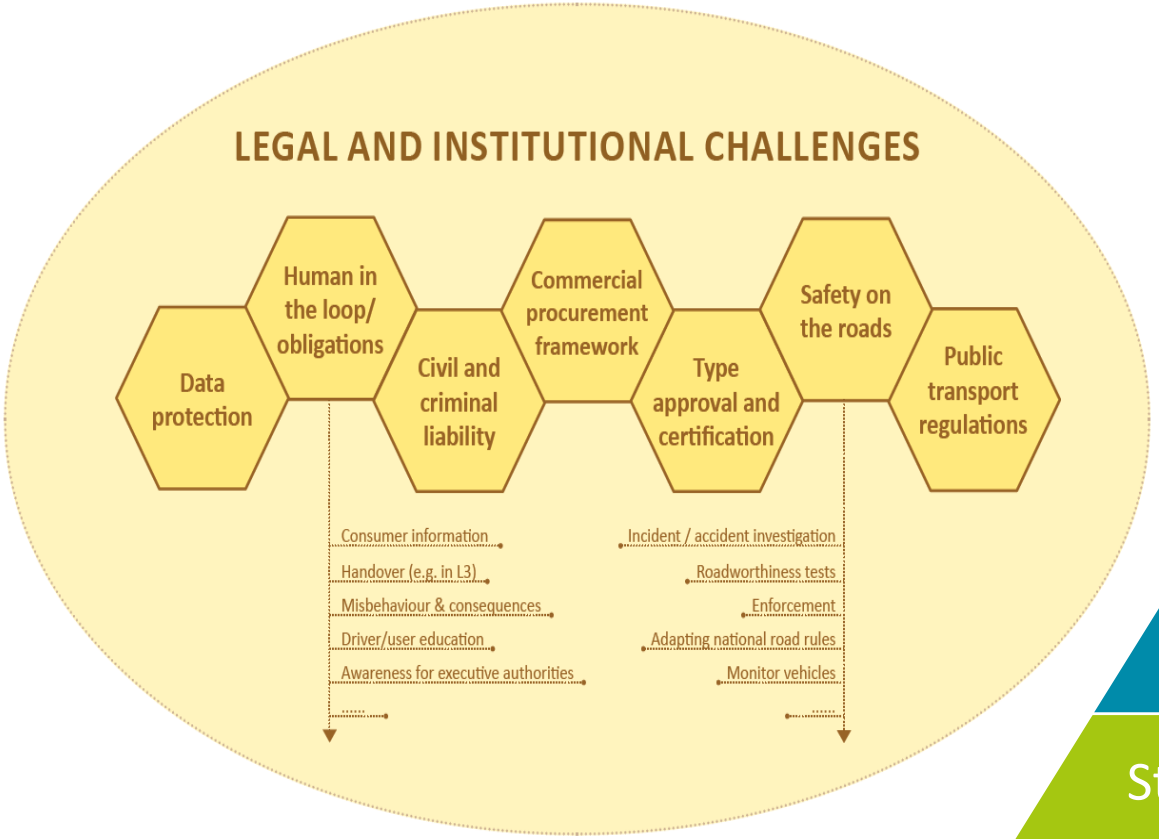
2_legal moonshots!?

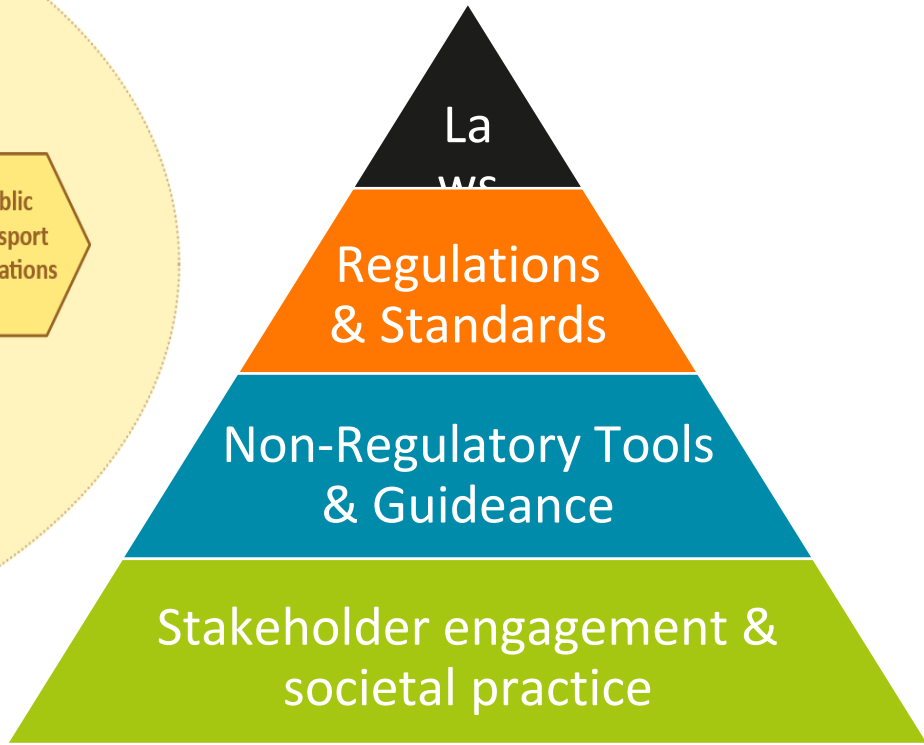
legal framework for create **efficient and effective testing** environments

Operations = next…

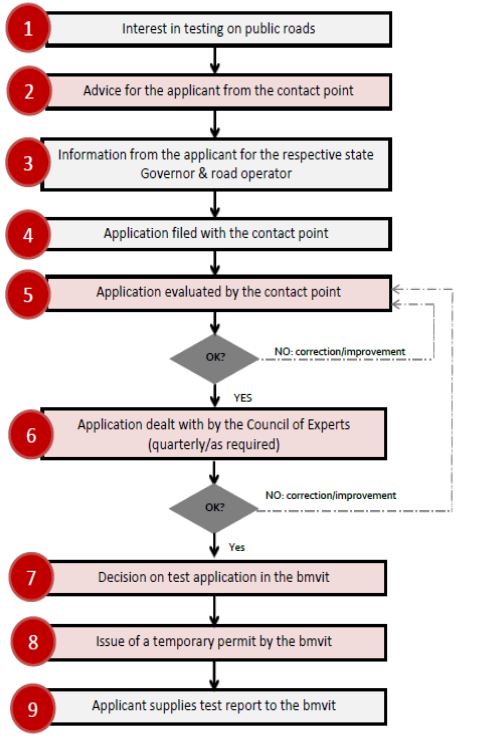
Safety, data protection & **human** obligations as actual challenges

“**sandboxes**” for future tests

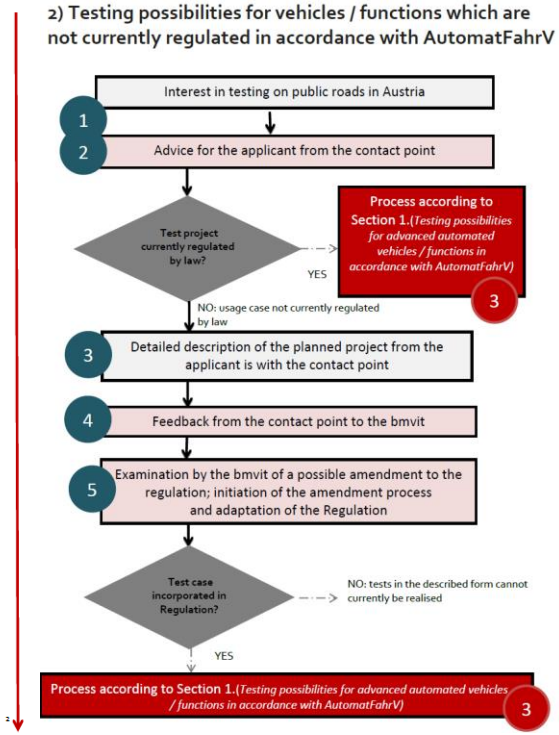

LEGAL AND INSTITUTIONAL CHALLENGES
Data protection
Human in the loop/ obligations
Civil and criminal liability
Commercial procurement framework
Type approval and certification
Safety on the roads
Public transport regulations
Consumer information
Handover (e.g. in L3)
Misbehaviour & consequences
Driver/user education
Awareness for executive authorities
Incident / accident investigation
Roadworthiness tests
Enforcement
Adapting national road rules
Monitor vehicles


La
ws
Regulations & Standards
Non-Regulatory Tools & Guideance
Stakeholder engagement & societal practice

Real Life Test-Procedures in Austria



The duration of the process varies depending on the test case as well as a possible need by the applicant to adapt the test procedure – the average duration can be indicated as being approx. 1-3 months.



Actual:

- Based on Use-Cases
- Type Approval Law
- Somewhat flexible
- Code-of-Practice
- Expert Council

Future Changes:

- Experimental Framework (Sandboxes)
- Traffic Situation (Road Code)
- Functional Edge-Case Scheme
- Clear role for existing test-environments

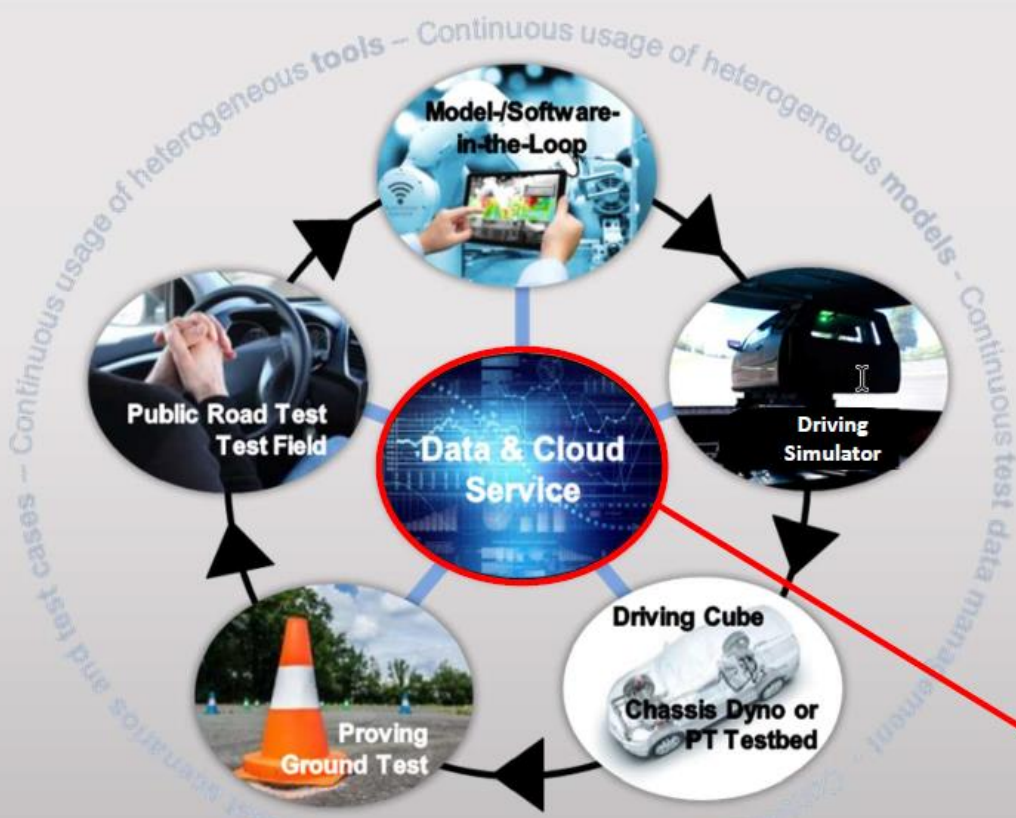
3_Infra, Simulation & Safe Testing

Scenario Development Loop

Common Ground

New Tools for assessing role of new Infra

Fully digital integrated Testinfrastructur für AD (Autonomous Driving) und ADAS (Advanced Driver Assistance Systems)



- ✓ **Model/Software/Hardware in the Loop**
  Bring in scenarios from road tests into virtual environment to test SW and HW functions
- ✓ **Driving Simulator**
  Test the Human-Machine Interface (HMI) for ADAS/AD specific situations, e.g. hand-over from vehicle to driver
- ✓ **Vehicle in the Loop (Driving Cube™)**
  Automated system evaluation of a complete vehicle in a reproducible environment on a test bed
- ✓ **Proving Ground Tests**
  Individual desired scenarios and manoeuvres, e.g. EuroNCAP
- ✓ **Public Road Tests**
  Test in regional specific real-world scenarios
- ✓ **Data and Cloud Services**
  Data processing and management
  Analysing and reporting
  Simulation environment

ALP.Lab

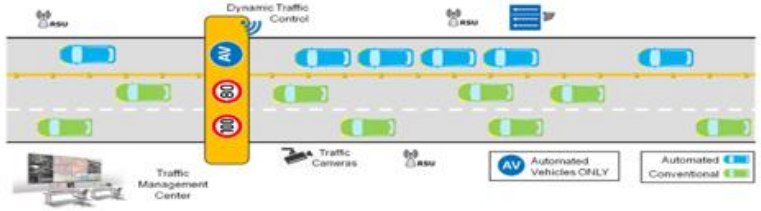
INFRAMIX - Road Infrastructure ready for mixed vehicle traffic flows

How the infrastructure can support automated and non-automated vehicles

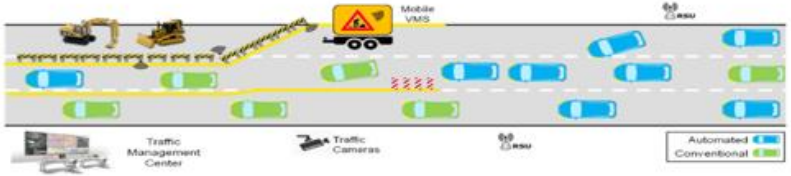
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723016.

INFRAMIX – Hybrid Infra & Testing Scenarios

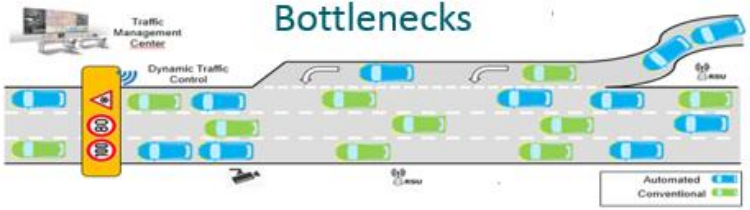
Dynamic lane assignment to automated driving



Roadworks zone



Bottlenecks



- Status quo of test sites and simulation tools as a starting point
- Definition of requirements (functional, feasibility, non-functional)

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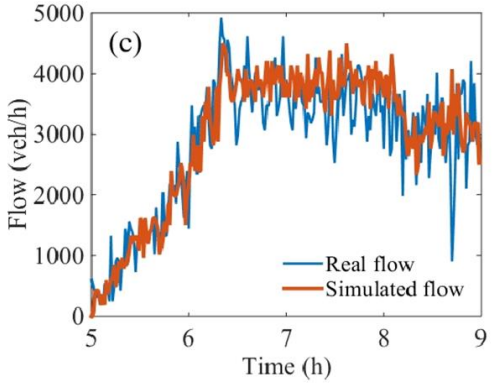
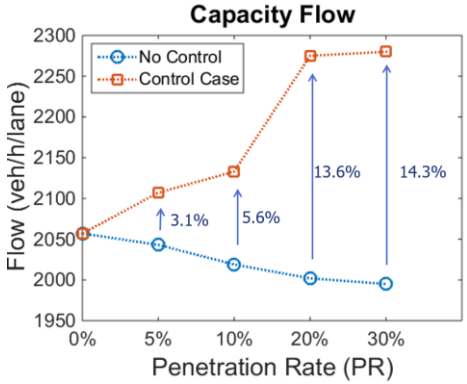
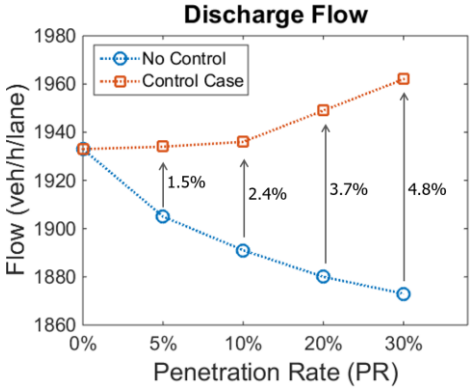
Traffic estimation & control

Design and implement novel **traffic estimation, monitoring and control strategies** dynamically adapted to

- the **different penetration levels of automated vehicles,**
- the **infrastructure equipment**
- and the **overall traffic status.**







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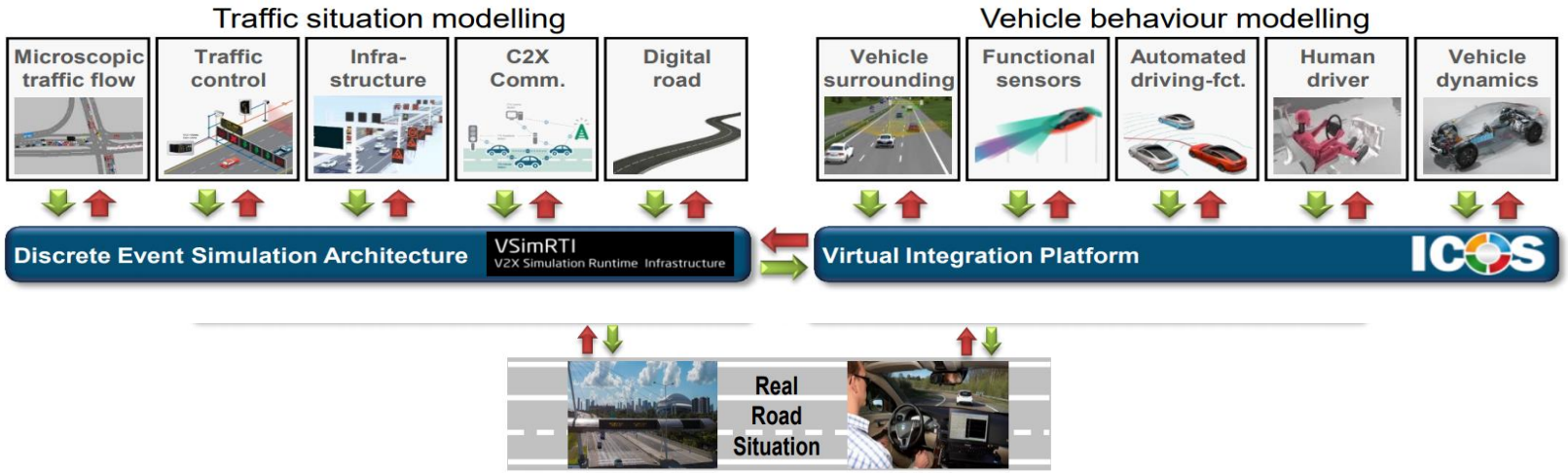
Hybrid testing system



Coupling infrastructure elements and vehicles on real roads with virtual traffic environment

- Enables detailed and realistic investigations of real driving behavior
- Testing of new developments of connected and automated driving
- Emulation of critical traffic situation in a safe artificial environment

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Summary

Evaluation Tools

- **Development of co-simulation framework**
- **Real world implementation**
- **Combination of real world and simulation (=Hybrid testing)**

Recommendations

- **Infrastructure classification scheme**
- **Safety performance criteria**

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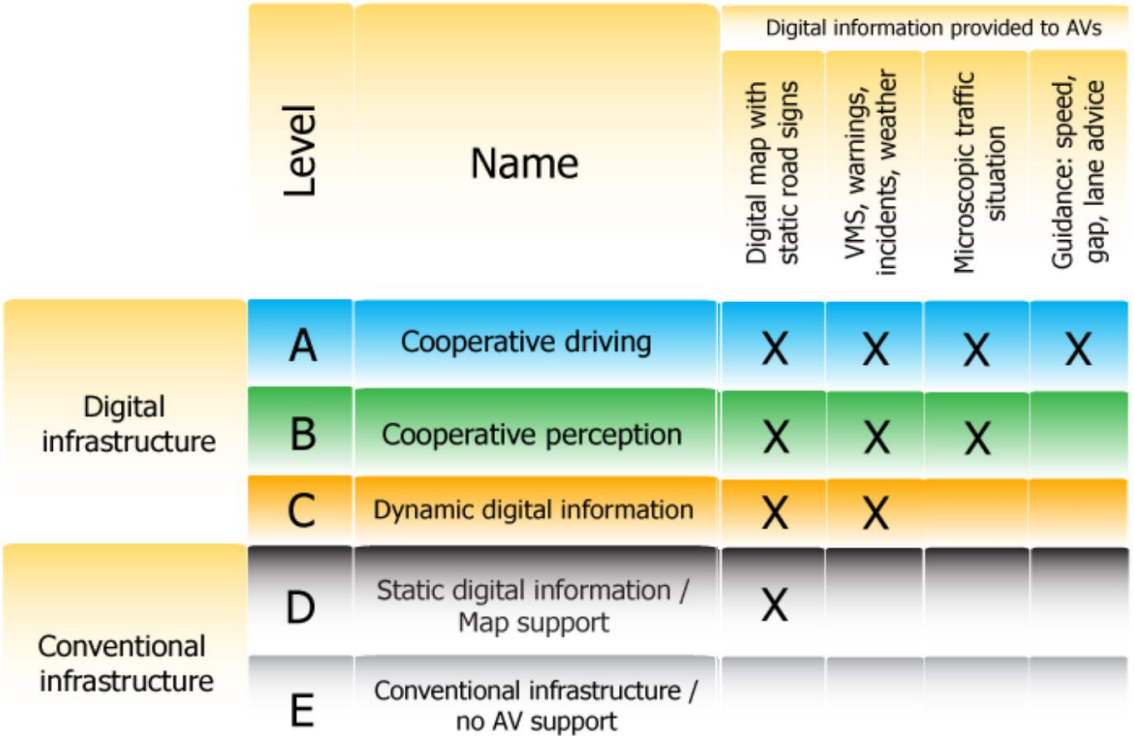
Infrastructure Support levels for Automated Driving (ISAD)



	Level	Name	Digital map with static road signs	VMS, warnings, incidents, weather	Microscopic traffic situation	Guidance: speed, gap, lane advice
			Digital information provided to AVs			
Digital infrastructure	A	Cooperative driving	X	X	X	X
	B	Cooperative perception	X	X	X	
	C	Dynamic digital information	X	X		
Conventional infrastructure	D	Static digital information / Map support	X			
	E	Conventional infrastructure / no AV support				

See also: ITS World Congress 2018 paper by Abertis Autopistas & ASFINAG, "Road infrastructure support levels for automated driving"

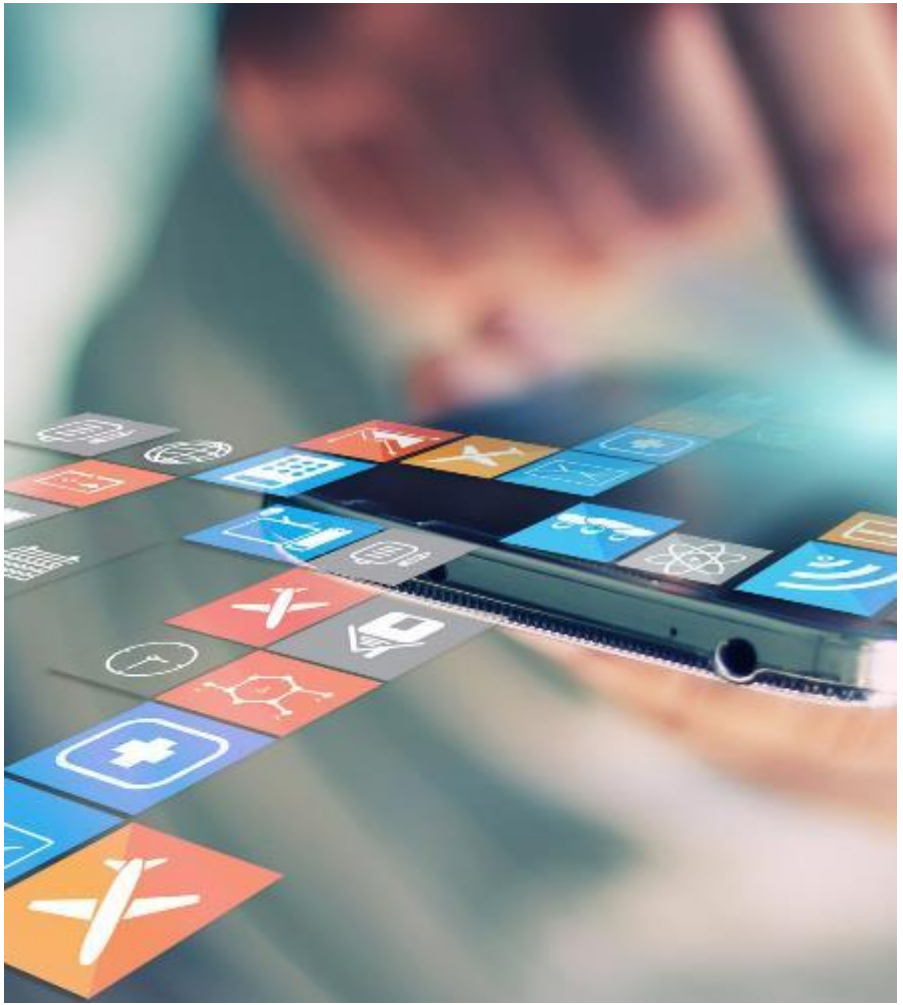
4_a way forward?

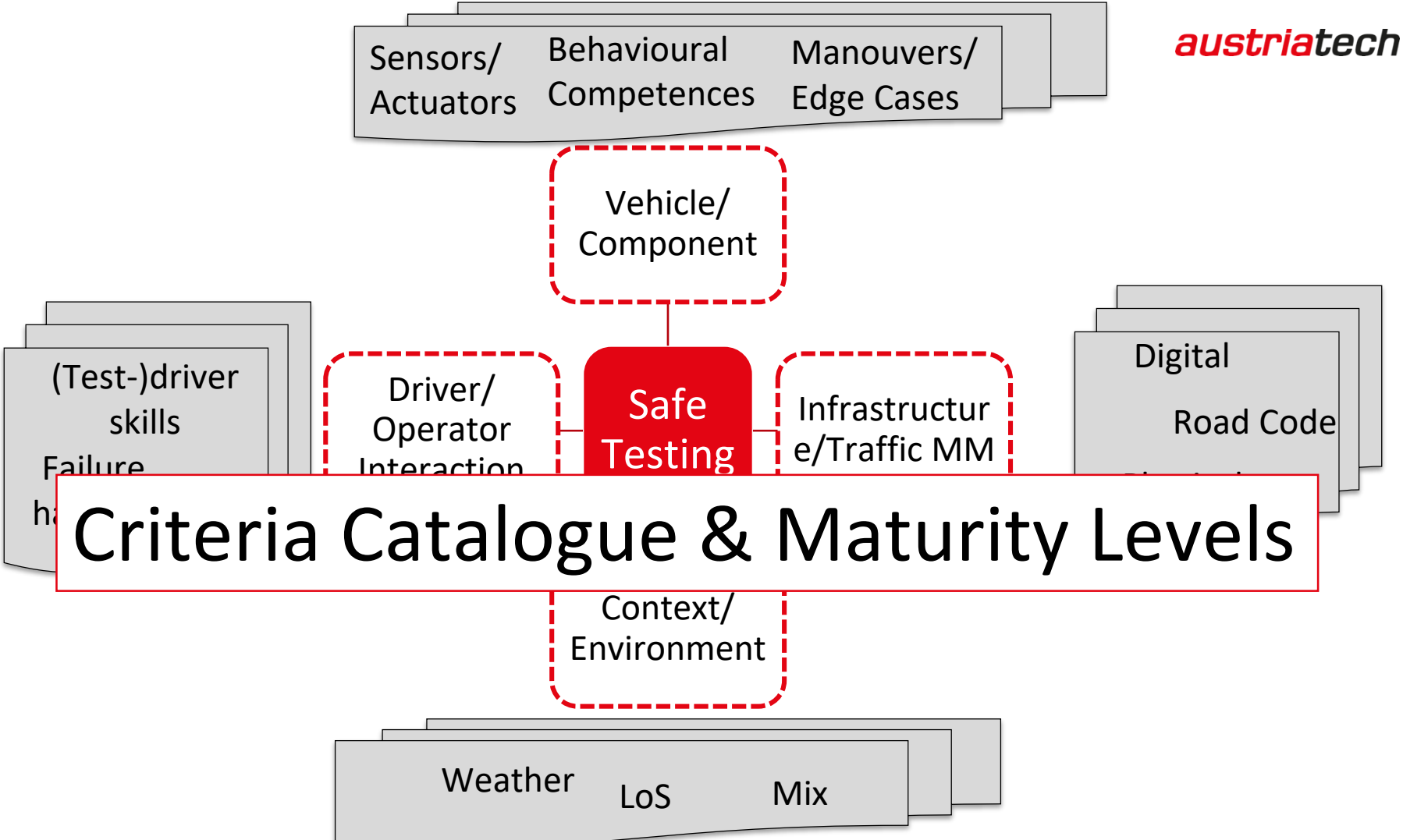
Common definition of „edge cases“

Assess behavioural competences

Allign test/exemption procedures

Safe testing > safe tech




Sensors/
Actuators
Behavioural
Competences
Manouvers/
Edge Cases
Vehicle/
Component
(Test-)driver
skills
Driver/
Operator
Interaction
Safe
Testing
Infrastructur
e/Traffic MM
Digital
Road Code
Criteria Catalogue & Maturity Levels
Context/
Environment
Weather
LoS
Mix