Adapting road infrastructures to the deployment of Connected & Automated Vehicles

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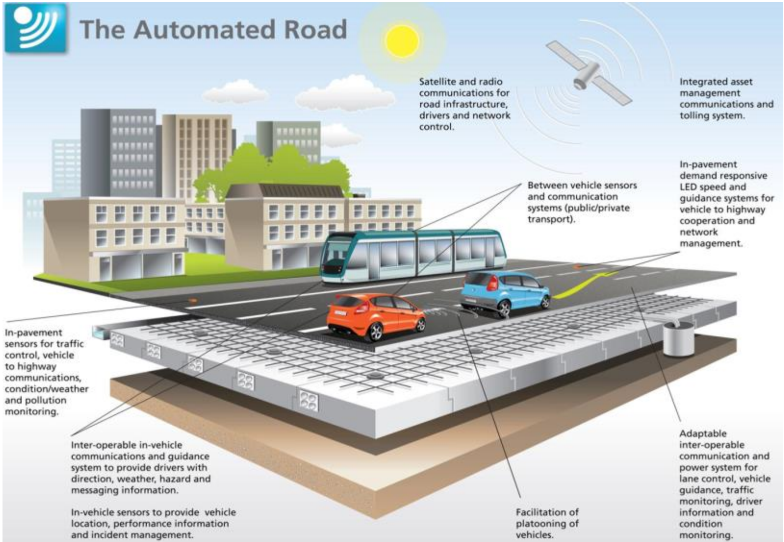
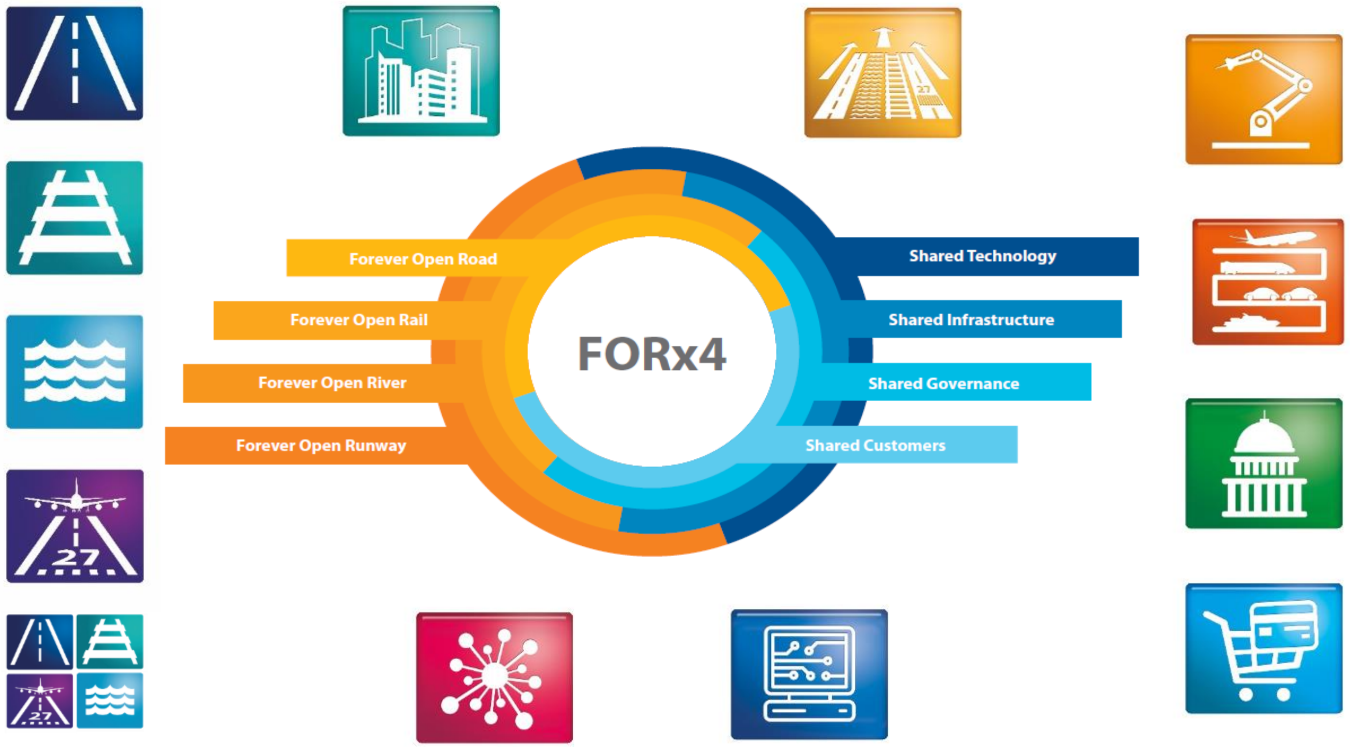
Towards a common VISION and understanding of research NEEDS

- **1st generation** - the bridge
- **2nd generation** - the paved road
- **3rd generation** - the smooth road
- **4th generation** - the continuous road/motorways
- **5th generation** - **FOREVER Open Road (FOR)**



FORx4
FOREVER Open and Integrated Transport Infrastructure



Cross-modal transfer

EUEIP European ITS Platform

EU ITS Platform (EU EIP) - H2020 project - https://eip.its-platform.eu/

- the place where:
- National Ministries, Road Authorities, Road Operators and partners from the private and public sectors of almost all EU Member States and neighboring countries -
- cooperate in order to foster, accelerate and optimize current and future ITS deployments in Europe in a harmonized way.

Work package 4.2 - Facilitating automated driving

Including:

- Impact of higher level (SAE 3-5) of automated driving to road authorities/operators' Physical and digital infrastructure;
- The socio-economic benefits and costs of automated driving from the road operator viewpoint;
- road map and action plan for especially road operators to facilitate automated driving on the TEN road network

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

Road map

European ITS Platform

Under development

- Reflection on EU-EIP roadmap position within other ongoing initiatives
- Way forward on physical & digital infrastructure from road operators perspective
- Way forward on cost & benefits from road operators perspective
- Update process for road map

Co-financed by the European Union
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Main achievements & lessons learned

- New features implemented in traffic modelling tool to allow simulation of automated vehicles. But still big responsibility on modeler to define the assumptions (about how vehicle should or will behave).
- Driving logics: much research is ongoing but there are still no fixed rules or standards and high uncertainties.
- Cities' expectation management: findings challenge the positive hype around CAVs- in particular for the transition phase. Learnings are more "how to prepare for planning!"
- All uncertainty requires a structured way of assessing future scenarios. CoEXist delivered the tools for a structured approach (e.g. automation-ready framework).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201-2

Main achievements & lessons learned

- All use case simulations show “hell” scenario before “heaven” scenario; transition phase!
- Inserting CAVs in traffic does not necessarily improve efficiency. Depends on penetration rate and driving logic. Higher penetration rates and less cautious (more advanced) CAVs will start to generate some gains.
- Opportunity of modal shift towards integrated PT with automated (shared) fleets; service needs to be affordable (social inclusion)! From “gut feeling” to a structured & informed decision-making!
- Tools developed enable assessment of innovative infrastructure measures, but:
  - Measures tested show mobility improvements mainly for high automation and penetration levels.
  - Should urban road change in the transition towards CCAM and how?
  - How to ensure other modes are not negatively affected by automated decision-making (e.g., light signal)?

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INFRAMIX Summary

Focus	• Mixed traffic: Automated & connected, connected, conventional vehicles (different levels of penetration) • Road infrastructure (high level road network)
3 Key Scenarios	• Dynamic lane assignment • Roadworks zone • Bottlenecks
Solutions	• Comprising new traffic management and control strategies, new physical and digital road infrastructure elements (define, specify, develop, implement)
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 • Roadmap towards a fully automated transport system • Exploitation plans

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Infrastructure Support levels for Automated Driving (ISAD)

	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
Conventional infrastructure	E	Conventional infrastructure / no AV support	Conventional infrastructure without digital information. AVs need to recognise road geometry and road signs.				
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			
Digital infrastructure	C	Dynamic digital information	All dynamic and static infrastructure information is available in digital form and can be provided to AVs.	X	X		
Digital infrastructure	B	Cooperative perception	Infrastructure is capable of perceiving microscopic traffic situations and providing this data to AVs in real-time.	X	X	X	
Digital infrastructure	A	Cooperative driving	Based on the real-time information on vehicle movements, the infrastructure is able to guide AVs (groups of vehicles or single vehicles) in order to optimize the overall traffic flow.	X	X	X	X

Road infrastructure support levels for automated driving, Anna Carreras, Xavier Daura, Jacqueline Erhart,Stefan Ruehrup, 25thITS World Congress, Copenhagen, Denmark, 17-21 September 2018

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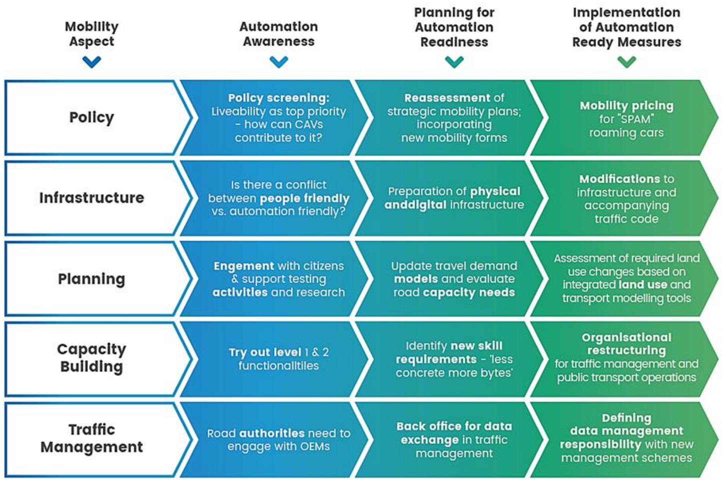
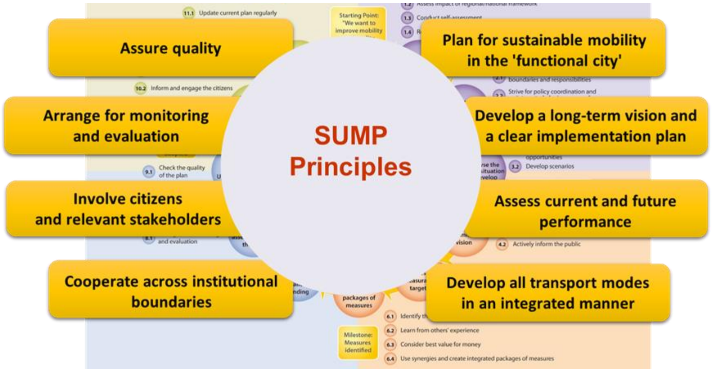
How to tackle the imminent disruption to mobility generated by CAV deployment?



- Authorities should look at planning for CCAM as an element of a more **fundamental change process: proactive action** to get ready for the challenges of conducting planning processes towards CAV deployment.
- Planning for CCAM should be **based on analyses of all modes** and supported by all **stakeholders** (and not on on SAE perspective).
- Transport and infrastructure planning through adequate tools: **automation-ready modelling functionalities** & **impact assessment** framework, with strategically defined **Key Performance Indicators** in relation to **local policy goals**.
- In addition to (old) risks, **new opportunities** for sustainable urban development arise – spur **flexibility** and create **room for experiments**.



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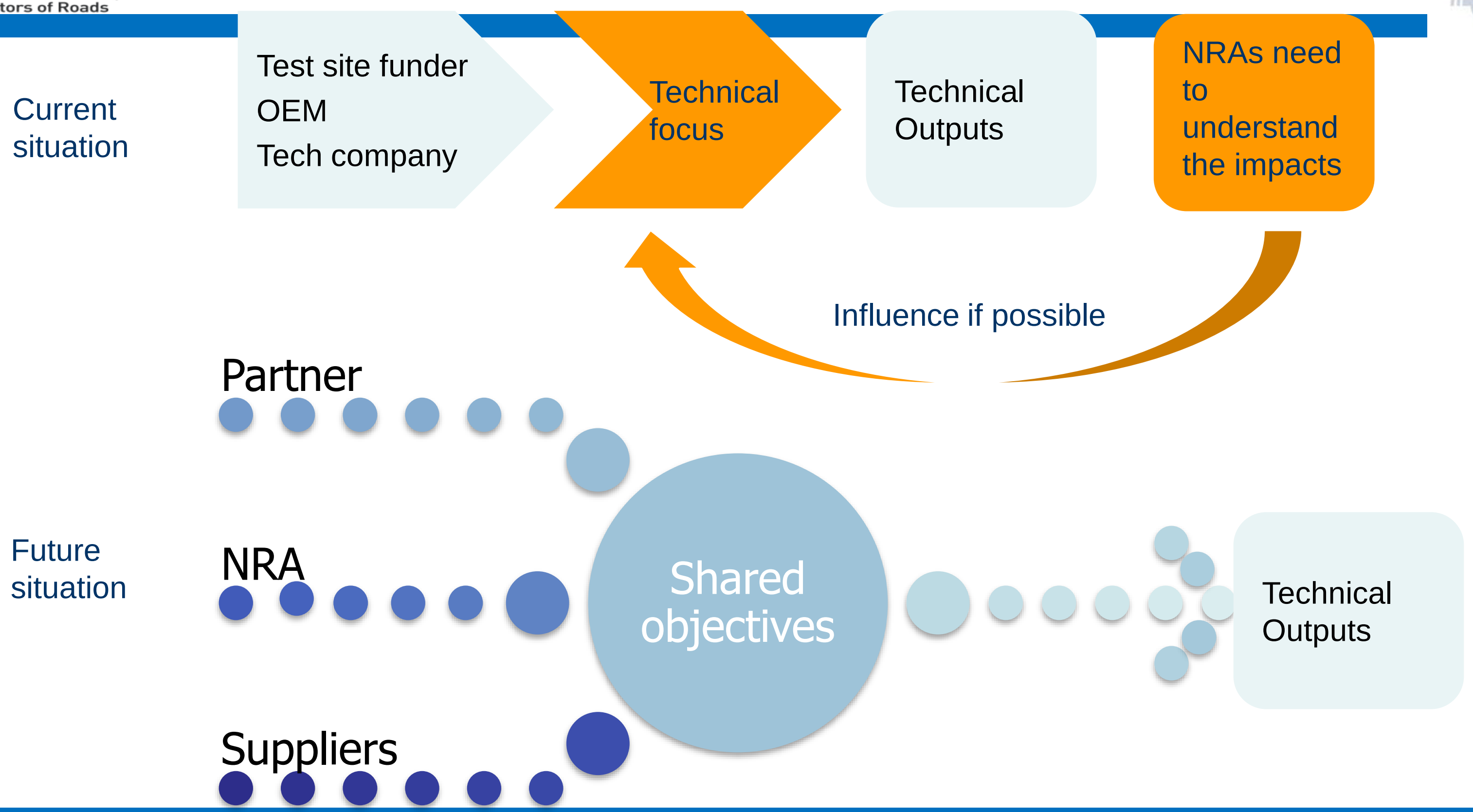
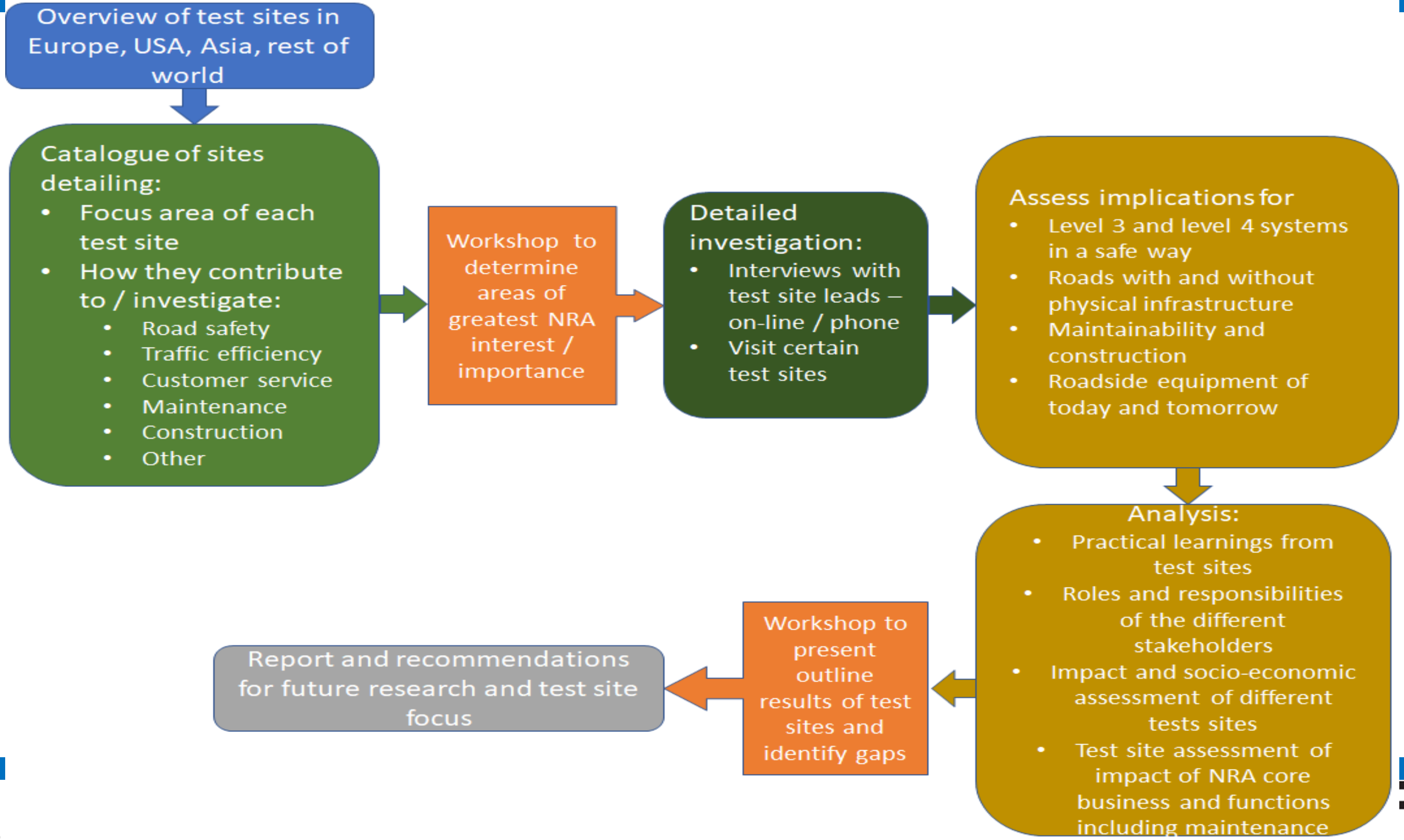
CoEXist

CAV Trials


Current situation
Test site funder
OEM
Tech company
Technical focus
Technical Outputs
NRAs need to understand the impacts
Influence if possible
Future situation
Partner
NRA
Suppliers
Shared objectives
Technical Outputs

Outline of general methodology

1st Phase



NRAs and Digitalisation

Key Findings

- ***Collaboration*** is a significant barrier which can only be improved through the NRA's direct involvement in projects with other relevant actors. Through collaboration 'trust' will be built between the actors, particularly in relation to data
- ***Holistic approach*** is required with involvement of all actors, including but not limited to NRA's, Governments, third parties, road operators and other stakeholders
- ***Testing*** is a significant prerequisite for the implementation of C-ITS and even more so for automated driving
- ***Disparity*** in levels of Digitilisation & Automated Driving across countries (planning, development, implementation/deployment)
- **Others** include;

  Financial barriers/uncertainties; Roles and responsibilities unclear; legal/regulatory issues; public acceptability; Interoperability; Data issues (privacy, cybersecurity, sharing, quality, ownership etc.); Skills requirements

DIRIZON USE CASE 1	
Use Case Name	Provision of HD Maps for Automated Mobility
Use case reference /id	DIRIZON-UC-1
Description	The provision of detailed mapping in a machine-readable format supports a connected automated vehicle's (CAV) ability to understand its precise positioning, plan beyond sensor visibility, possess contextual awareness of the environment and local knowledge of the road rules. Hence, HD Maps can assist automated vehicles to optimize:

DIRIZON USE CASE 2	
Use Case Name	Distribution of Digital Traffic Regulation
Use case reference /id	DIRIZON-UC-2
Description	Distribution of digital traffic regulation becomes more and more relevant for CAM (Connected and Automated Mobility as well as for other areas such as smart cities, and is currently being addressed in more detail within CEN/TC 278 WG17. It has been found that, currently legal responsibilities and authorisation schemes vary a lot between countries, states and cities.

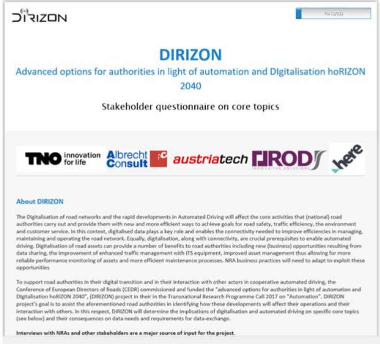
DIRIZON USE CASE 3	
Use Case Name	Infrastructure Support Services for CAD
Use case reference /id	DIRIZON-UC-3
Description	Infrastructure support for Connected and Cooperative Automated Driving (ISAD) is digitized information, including representations of the physical environment, to support CAD functioning. Map data could be complemented by physical reference points (landmarks, signs, beacons). This Use Case provides digital and physical infrastructure support (including traffic management measures) of vehicles in a mixed environment, supporting CAVs by extending their ODD's and improving safety, traffic flow and environmental impacts.

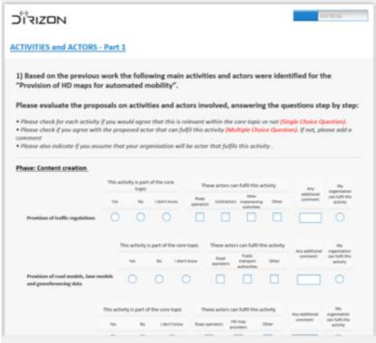
Data Quality Criteria

Criterion	Definition
Geographical coverage	Road classification in the road network covered by the service
Refreshment rate	The rate at which the data are updated in the vehicle, regardless if there has been a change in the data provided or not
Availability	Percentage of the time that the service is available with fresh data. Expressed as a percentage of the time
Timeliness/ Latency	the total time between the detection of a change and the delivery to the user
Location accuracy	Accuracy to within a specific distance
Classification correctness	Correct identification of, e.g., a static road element, a vehicle type, event or condition, or a dynamic regulation
Event coverage	Percentage of the actually occurring events which are known to be correctly detected and published by type / class, time and location
Variance	for many or all of the criteria, a variance should be provided
Predictability	use of information in forming predictions (this criterion results from the experience of Service Providers with data provided for Green Light Optimal Speed Advisory (GLOSA)).

Other Stakeholder Views

- **Collecting views of *other* stakeholders (based on the 3 Use Cases) on:**
  - Activities and actors
  - Data needs
  - Data exchange (incl. prerequisites)
  - Roles and responsibilities
  - Security, Data protection, Privacy
  - Governance
  - Challenge the views of NRAs with the results of other stakeholder groups





Towards a digital platform

- **Provide data-exchange (platform) options by focusing on connected stakeholders**
  - Any future Cooperative Connected and Automated Mobility (CCAM) scenario will generate a need for substantial improvements in data exchange between backends of road authorities, service providers & OEM backends (cloud-to-cloud services).
  - Appropriate services would pave the way for providing data services directly into vehicles, mobile devices or aftermarket devices used inside vehicles and, vice versa, providing sensor-data back to the connected backends.

- **Current focus on**
  - Current developments and transferable, decentralized platform concepts like the International Data Space.
  - Potential cooperation models between NRAs, service providers and OEMs like the Data Task Force Proof of Concept (PoC) and further developments regarding National Access Points.
  - Derivation of data exchange requirements and related data exchange options.

Exploration of Business Models

- **Identify which roles and business models drive the exploitation of the data-exchange concepts.**
  - Digital services in any future CCAM scenario will be created and delivered by an ecosystem of international and national, governmental and commercial, small and large service providers using in-car, mobile or aftermarket devices.
  - The data-exchange concepts and their governance must ensure that these service providers (*including* NRAs) are optimally facilitated in the creation and proper functioning of these services is, e.g. by providing added value elements, e.g. by enriching services, toolkits, good governance and consistent access in all countries
  - From the perspective of the service providers, whose use determines the value of the data-exchange, a seamless and uniformly available platform for building their services on top of would be ideal. But how to realise that decentrally, with which governance and conditions?
- **Current focus on**
  - Current developments and transferable, decentralized platform concepts like the International Data Space (IDS).
  - Potential governance models between NRAs among themselves and service providers and OEMs.
  - Linking scenarios, data-exchange concepts, international heterogeneity, implications for exploitation and future pathways to facilitate

Thank you for your attention and for your cooperation

More information at www.fehrl.org