D8.1

Stakeholder consultation report

Project Acronym	TransAID	
Project Title	Transition Areas for Infrastructure-Assisted Driving	
Project Number	Horizon 2020 ART-05-2016 – GA Nr 723390	
Work Package	WP8 Guideline and Roadmap	
Lead Beneficiary	MAP traffic management (MAP)	
Editor / Main Author	Jaap Vreeswijk	MAP
Reviewers	Michele Rondinone	HMETC
Dissemination Level	PU	
Contractual Delivery Date	Initial version: M21 (May19), Revised version: M35 (July20)	
Actual Delivery Date	M36 (Aug20)	
Version	v1.0	

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

Document revision history

Version	Date	Comments
v0.1	15/10/2019	Document structure
v0.2	24/10/2019	Integration of content first workshops
v0.3	28/10/2019	Integration of content latest workshops
v0.4	31/10/2019	Version for peer-review
v0.5	11/11/2019	Version for submission
v0.6	31/07/2020	Draft version for internal review
v0.7	04/08/2020	Version for peer-review
v1.0	06/08/2020	Final version

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Dissemination level:

■ PU: Public

□ RE: Restricted to a group specified by the consortium (including the Commission Services)

□ CO: Confidential, only for members of the consortium (including the Commission Services)

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Executive Summary

The TransAID project defines, develops and evaluates traffic management measures based on C-ITS equipped road infrastructure to eliminate or mitigate the negative effects of Transition of Control (ToC) along Transition Areas in future mixed traffic scenarios where automated, cooperative, and conventional vehicles will coexist.

This document summarises the results of the stakeholder consultation activities of the TransAID project. For TransAID, the most relevant stakeholders are transport authorities and policy makers, road operators, vehicle manufacturers and suppliers, road infrastructure and traffic service providers, academia and knowledge institutes, future product owners and standardisation bodies. The consultation activities aimed to gather feedbacks on the project choices (selected use cases, scenarios, modelling solutions, implementation approaches) as well as on the achieved results. Such feedbacks were necessary to confirm the validity of the project's work, and to adapt, whenever possible and needed, its implementation while running. Consultation also allowed obtaining the stakeholders' view on the impact of prospective automated vehicles introduction. Finally, the stakeholders were asked about their ambitions and interests related to role and responsibilities in future scenarios of automated vehicle presence. Hearing about these last two aspects was necessary to identify possible activities beyond the TransAID project's duration.

A summary of 9 stakeholder consultation events is provided in this deliverable:

Main stakeholder workshops

- TransAID-MAVEN-CoExist Stakeholder workshop, 10 October 2017, Brussels
- TransAID-INFRAMIX stakeholder workshop, 9 October 2019, Graz
- TransAID final event, stakeholder workshop, 2 July 2020, online

International liaison activities

- TransAID-U.S. CAMP expert meeting, 25 July 2019, Detroit
- TransAID + ITS Japan / UtmobI expert meeting, 7-8 April 2020, online

Additional stakeholder consultation opportunities

- TransAID session and survey, 8 June 2019, IEEE-IV, Paris
- EU EIP workshop on ODD, 1 October 2019, Turin
- International workshop on ODD, 22 October 2019, Singapore
- Joint dissemination of H2020, CEDR projects and other initiatives related to CAVs and Infrastructure, 3 March 2020, Brussels

For each stakeholder consultation event, this deliverable gives a detailed description of the scope and aim, participants, plenary and break-out sessions, survey results (when applicable) and implications to the TransAID work.

The main common findings that have been identified throughout the various events are listed in the following along with the major implications for TransAID and/or any similar follow-up activity:

- Managing mixed traffic in transition areas is still an almost unexplored field. Despite transition areas are recognized as a prospective problem, very little is known or has been studied about it. This simple acknowledgment confirms the need and timeliness of TransAID.

- Due to the uncertainty about many technical aspects related to the introduction of AD, it was difficult for transport authorities and traffic managers to provide insights on aspects to be considered for the selection of TransAID use cases and scenarios. Nevertheless, the majority of use cases and scenarios finally selected by TransAID were recognized to be reasonably generic, yet addressing recurrent problems, and hence deemed useful for real-world application.

- Connectivity was recognized as a key enabler to extend the Operational Design Domain (ODD) of AD. In this sense, most experts foresee application of hybrid solutions with both ITS-G5 and cellular connectivity capabilities. For this purpose, TransAID's assumption of digitalizing the road infrastructure with additional sensing, computing and communication capabilities was acknowledged to be correct, even if maybe not realisable in the short term.

- TransAID traffic management allowing the road infrastructure to provide additional information to CAVs was also recognized as a valid approach in almost all the consultation and twinning events. In this context, European and Japanese stakeholders firmly defend the use of infrastructure support for automated driving and even highlight the need to adapt traffic rules for automation or change the legal frameworks (e.g. authorize the road infrastructure to provide advices that break the traffic rules if needed). On the contrary, US stakeholders are very hesitant and fear possible financial consequences resulting from liability issues.

- Remote operation is an emerging possible solution at least for management of level 4 automated public transport (e.g. autonomous shuttles or pods) in edge cases and transition areas, when the vehicles operate without a steward in the vehicle. This use case is not considered by TransAID, and hence it would be interesting to investigate its effectiveness with similar evaluations means as those utilized by TransAID.

- Sensitivity of information around OEMs' current and future implementations has prevented obtaining commonly recognized functional descriptions reusable for modelling and simulations of automated vehicles behaviours. Despite that, the modelling solutions developed in the project under the consultancy of Hyundai were considered adequate and meaningful by the inquired stakeholders.

- For the TransAID measures to work effectively, vehicle AD capabilities shall be known by the infrastructure, and infrastructure (support) capabilities shall be known by OEMs. Consequently, sharing this data in both directions is needed. From the consultation, this approach was welcomed by infrastructure stakeholders while OEMs were more hesitant mostly due to competition and liability implications arising from sensitivity of the shared information. To preserve sensitivity of information, the TransAID "intermediary service" concept (see TransAID D4.3) was generally supported, but its practical application in real-world deployment scenarios would need to be proven.

- In addition, it is considered needed to derive clear and unambiguous definitions of AD ODDs for adoption at both OEMs and infrastructure side. Transport Authorities could use this information for allowing vehicles of different automation capabilities to use specific roads or to provide additional physical of digital support where needed. Nevertheless, defining ODDs is a complex task for the involved stakeholders, and despite initial activities have been started and proposals have been made, there is still a long way to go.

- From an even more generic perspective, transport authorities (especially cities) are mostly interested in fulfilling their greener, safer and comfort goals and see AD as an opportunity in that direction. For the moment being, they are not favouring a particular automated transport mode in a proactive way. Rather, they seem to be monitoring the situation to apply reactive policies when AD introduction will be more mature and clearer. In fact, adoption of alternative policies like strategically “managing” private CAVs vs. fostering use of MaaS with public automated shuttles will depend on penetration. For TransAID, it is irrelevant which way authorities will choose, as the proposed TransAID solutions can apply irrespectively of the selected automated transport mode.

As it can be seen, some of the findings from the consultation events reflect the uncertainty associated to vehicle automation and its evolution in the coming decades.

Nevertheless, from the sequence of stakeholder consultation events a steady progression in the collective understanding of the relation between vehicle automation and infrastructure could be observed. The possible implications to the stakeholders involved became also clearer at subsequent events.

1 Introduction

In the following sections, we first give a concise overview of the TransAID project, then highlight the purpose of this document, and finally present its structure.

1.1 About TransAID

As the introduction of automated vehicles becomes feasible, even in urban areas, it will be necessary to investigate their impacts on traffic safety and efficiency. This is particularly true during the early stages of market introduction, where automated vehicles of all SAE levels, connected vehicles (able to communicate via V2X) and conventional vehicles will share the same roads with varying penetration rates.

There will be areas and situations on the roads where high automation can be granted, and others where it is not allowed or not possible due to various reasons (missing sensor inputs, highly complex situations, etc). As a consequence, there will be areas where many automated vehicles will need to change their level of automation to adopt more conservative operations or even give the control back to manual driving (Transition of Control, ToC in short). We refer to these areas as “Transition Areas” (TAs).

It can be expected that especially at Transition Areas the simultaneous presence of automated, connected, and conventional vehicles will be challenging and possibly negatively affect safety and traffic efficiency. To cope with these challenges, TransAID develops and demonstrates traffic management procedures and protocols to prevent or mitigate the negative effects of ToC at TAs, hence enabling smooth coexistence between different types of automated and non-automated vehicles.,. A hierarchical approach is followed where control actions are implemented at different layers including centralised traffic management, infrastructure, and vehicles.

First, simulations are performed to find optimal infrastructure-assisted management solutions to control connected, automated, and conventional vehicles at Transition Areas, taking into account traffic safety and efficiency metrics. Then, communication protocols for the cooperation between connected/automated vehicles and the road infrastructure are developed. Measures to detect and inform conventional vehicles are also addressed. The most promising solutions are then implemented as real world prototypes and demonstrated under real urban conditions. Finally, guidelines for enabling the TransAID vision on advanced infrastructure-assisted driving are formulated. These guidelines also include a roadmap defining activities and needed upgrades of road infrastructure in the upcoming fifteen years (i.e. the average life cycle of physical and digital infrastructure) in order to guarantee a smooth coexistence of conventional, connected, and automated vehicles.

Iterative project approach

TransAID performs its development and testing in two project iterations. Each project iteration lasts half of the total project duration. During the first project iteration, the focus is placed on studying Transitions-of-Control (ToCs) and Minimum-Risk Manoeuvres (MRMs) using simplified scenarios. To this end, models for automated driving and ToC/MRM are developed and adopted. The simplified scenarios are used for conducting several simulation experiments to analyse the impacts of ToCs at TAs, and the effects of corresponding mitigating measures.

During the second project iteration, the experience accumulated during the first project iteration is used to refine/tune the driver models and enhance/extend the proposed mitigating measures. Moreover, the complexity and realism of the tested scenarios is increased by also combining multiple simplified scenarios into new and more complex use cases.

1.2 Purpose of this document: the stakeholder consultation

The purpose of this document is to give a summary of the results of the TransAID stakeholder consultation activities as part of work-package 8. In the context of TransAID, the most relevant stakeholders are authorities and policy makers, road operators, vehicle manufacturers and suppliers, road infrastructure and traffic service providers, academia and knowledge institutes, future product owners and standardisation bodies. The consultation activities aimed to gather feedbacks on the project results, as well as to hear the stakeholders' view on the impact of prospective automated vehicles introduction. Most importantly, the stakeholders were asked about their ambitions and interests related to role and responsibilities in future scenarios of automated vehicle presence. To this end, TransAID has organised multiple workshops or participated actively in them. In addition to the three workshops foreseen at the start of the project, several other events provided opportunities to gather stakeholder feedback. A full list is given in section 1.3.

As shown in Figure 1, the general idea is that project results are aggregated and processed and then used as input to stakeholder workshops. The feedback gathered at the workshops are recommendations for future project tasks and will be used as input to D8.3 Guidelines and Roadmap. Finally, the stakeholder workshops are an instrument to liaise with other ART-projects under Horizon 2020.

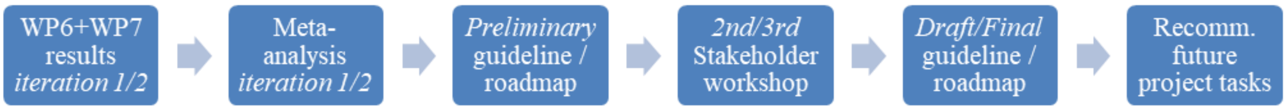

Figure 1: work plan for the creation of this document

1.3 Structure of this document

The following chapters each give a summary of one stakeholder consultation event:

Main stakeholder workshops

- TransAID-MAVEN-CoExist Stakeholder workshop, 10 October 2017, Brussels
- TransAID-INFRAMIX stakeholder workshop, 9 October 2019, Graz
- TransAID final event, stakeholder workshop, 2 July 2020, online

International liaison activities

- TransAID-U.S. CAMP expert meeting, 25 July 2019, Detroit
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Additional stakeholder consultation opportunities

- TransAID session and survey, 8 June 2019, IEEE-IV, Paris
- EU EIP workshop on ODD, 1 October 2019, Turin
- International workshop on ODD, 22 October 2019, Singapore
- Joint dissemination of H2020, CEDR projects and other initiatives related to CAVs and Infrastructure, 3 March 2020, Brussels

In each chapter the scope and aim of the workshop is given together with an overview of workshop participants, a report of the plenary session, a report of the break-out sessions, summary of survey results (when applicable) and the implications of the workshop findings to the TransAID project. Finally, in the last chapter an overall summary is provided. Note that for several events a specific report was created either by TransAID or one of the other organisers. Consequently, there are differences in style between the different reports.

1.4 Glossary

ACC	Adaptive cruise control
AD	Automated Driving
AI	Artificial Intelligence
AV	Autonomous vehicle
C-ACC	Cooperative adaptive cruise control
C-ITS	Cooperative intelligent transportation systems
CAD	Connected and Automated Driving
CAV	Cooperative and autonomous vehicle
CCAM	Cooperative Connected and Automated Mobility
DG RTD	Directorate-General for Research and Innovation
EC	European Commission
GLOSA	Green Light Optimal Speed Advisory
I2V	Infrastructure to vehicle communication
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
EIP	European ITS Platform
ISAD	Infrastructure Support Levels for Automated Driving
ITS	Intelligent transportation systems
IV	Intelligent Vehicle
MRM	Minimum-risk manoeuvre
ODD	Operational Design Domain
OEM	Original equipment manufacturer
PRT	Personal Rapid Transit
PT	Public Transport
RSS	Responsibility-Sensitive Safety

RSU	Roadside Unit
SA	Sub-activity
TA	Transition area
ToC	Transition of control
TransAID	Transition Areas for Infrastructure-Assisted Driving
US DoT	United States Department of Transport
V2X	Vehicle to anything communication
VRU	Vulnerable Road User

1.4.1 ODD

The Operational Design Domain (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 (weather, daytime/night time, etc.), prevailing traffic law and regulations, and other domain constraints.

1.4.2 ISAD

The environmental perception of automated vehicles is limited by the range and capability of on-board sensors. Road infrastructure operators already employ numerous traffic and environmental sensors and provide information that can be perceived by automated vehicles. In order to classify and harmonize the capabilities of a road infrastructure to support and guide automated vehicles, INFRAMIX[1] has proposed a simple classification scheme (see Figure 2), similar to SAE levels for the automated vehicle capabilities [6, 7, 8]. These levels can be assigned to parts of the network in order to give automated vehicles and their operators guidance on the "readiness" of the road network for the coming highway automation era.

Infrastructure support levels are meant to describe road or highway sections rather than whole road networks. This reflects common practice of infrastructure deployment: Traffic control systems (sensors and VMS) are usually deployed on motorway sections where traffic often reaches the capacity limit (e.g. in metropolitan areas), whereas other motorway sections need no fixed installations of traffic control systems because traffic flow is rarely disrupted. If a complex intersection is covered by dedicated traffic sensors, traffic situation awareness (level B) and even AV guidance (level A) could be provided. Other sections provide only level C support, which includes that VMS data is made available via digital interfaces. Furthermore, in this example the secondary road network is covered partially by map support (Level D), some rural areas have no support. This example illustrates how ISAD levels can be used for a simple description of what automated vehicles can expect on specific parts of a road network.

[1] https://www.inframix.eu/

				Digital information provided to AVs			
	Level	**Name**	**Description**	**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.				
	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		
	B	Cooperative perception	Infrastructure is capable of perceiving microscopic traffic situations and providing this data to AVs in real-time.	X	X	X	
	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

Figure 2: Levels of the Infrastructure Support for Automated Driving

2 Main stakeholder workshops

2.1 TransAID-MAVEN-CoExist Stakeholder workshop, 10 October 2017, Brussels

2.1.1 Scope and aim of the workshop

The H2020 projects hosting this workshop, CoEXist, MAVEN and TransAID, are all exploring the implications of increasing vehicle automation. They are mainly considering the traffic management and infrastructure aspects of connected and automated vehicles (CAVs). CoEXist is also exploring the transport planning and policy dimensions.

Consultation with national/regional/local authorities, especially city authorities and traffic managers, was important for each of these projects. Given the projects' synergies in terms of content and timing as well as the partnership overlap, the organisation of a joint workshop targeting local authorities offered a logical and efficient way to proceed. This workshop followed a successful workshop for local authorities organised by MAVEN in Barcelona in November 2016 [1]. Neither CoEXist nor TransAID had started at that time.

The primary aim of this workshop was to gather the views and requirements of local authorities and other urban transport stakeholders on various tasks underway or planned within the projects, specifically:

- the CoEXist automation-ready framework
- the MAVEN transition roadmap
- the TransAID list of situations for which automation is inappropriate or a threat

The workshop agenda was divided into two parts:

- the morning plenary session saw an introduction to the three projects, to the CAV activities of two projects’ partner cities as well as insights to research in this field and the wider city/regional authority perspective on CAVs.
- the afternoon session comprised project sessions in smaller groups to encourage interaction.

2.1.2 Workshop participants

The audience was targeted at urban transport stakeholders, with a particular emphasis on representatives of local and regional governments. The following charts provide a breakdown of attendance by sector and by country. Given the high number of representatives from transport authority, the workshop met its target audience goal.

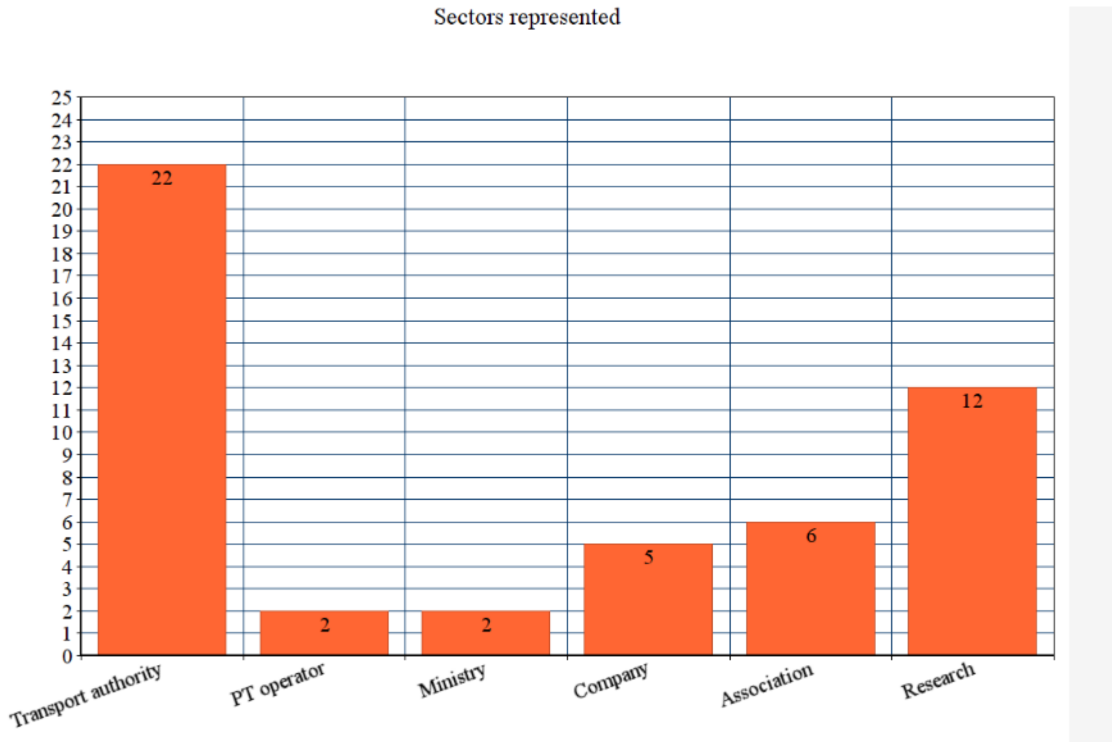


Figure 3: overview of workshop participants by sector

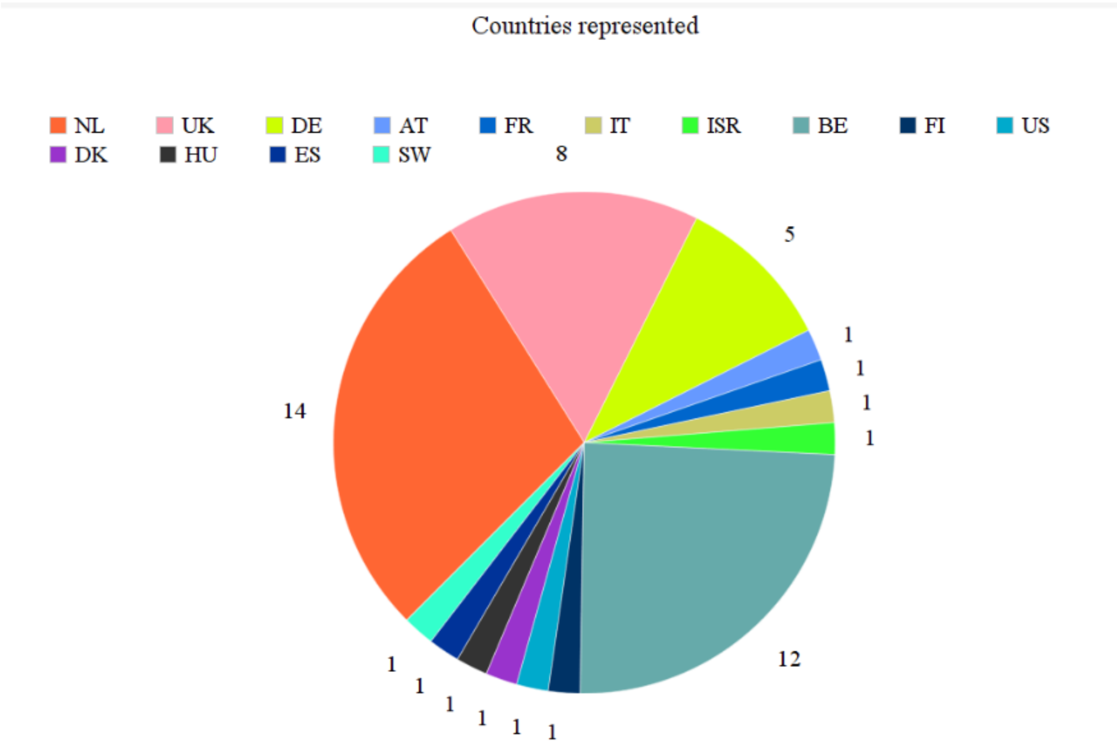


Figure 4: overview of workshop participants by country

2.1.3 Report of plenary session

After an introduction on the workshop objectives and the complementarity of the CoExist, MAVEN and TransAID projects, Bip Radia from INEA[2] contributed a few words about the work of the agency on vehicle automation. While he acknowledged the value of bringing together representatives of city and regional authorities to talk about vehicle automation, he also stressed the importance of industrial R&D as a key driver for this sector.

A quick overview of the CoExist, MAVEN and TransAID projects was given by the respective project coordinator or partner, as well as a brief introduction to the scope of the afternoon project breakout sessions. These project overviews were complemented by a presentation from Bart van Arem (TU Delft and advisory board member of MAVEN) who pulled together the results from a wide variety of other projects and studies on the topic of vehicle automation in cities. Some highlights of these findings include the following:

- Until the driver is fully relieved of the driving task, automation technology can mainly support safety and comfort.
- Automation should not be assessed in just transportation terms (safety, efficiency, etc). The economics, for instance, are equally important, notably in relation to time spent in congestion doing more productive things.
- High income males are more interested in certain vehicle technologies, such as adaptive cruise control (a key enabler of vehicle automation) than other inquired categories.
- Private level 4 automation vehicles are not expected to be widespread (commercially) available on the roads for another 10 years because of the technical complexity and other barriers such as trust and regulatory frameworks (including liability).

The session then moved onto the automated vehicle activities of two city councils which are part of MAVEN and CoEXist respectively:

- Greenwich: this London borough is very active in European and national-funded projects dealing with transport and smart city innovation. A key driver for these projects is finding solutions to respond to the demographic and social challenges that the borough is facing: notably (i) a substantial population growth and the mobility demands it will generate that will be difficult to accommodate on an already saturated public transport network and (ii) growing poverty. The CAV projects on which Greenwich is working include some activities related to data, notably understanding what would be the demands of CAVs on the digital infrastructure (and finding that the existing infrastructure is wholly inadequate), and some others focusing on customer perception and acceptance of CAVs.
- Gothenburg: this Swedish city will undergo massive change in the next 15 years due to major urban developments and population growth. The city is exploring how innovation and new technology can help reaching its sustainable goals but admits that it is not easy to establish longer-term objectives due to the rapid pace of technological change. Gothenburg expects CAVs to help achieving its policy goal of zero-vision safety and to reduce the cost and inconvenience of infrastructure measures designed to deliver a safer and calmer traffic

[2] EC agency implementing the CEF programme and parts of the H2020 programme

environment, notably speed bumps and road signs. The city council also expects automated vehicles to use less space and views digitalisation as being a key enabler of automation, connectivity, and electrification.

In the following discussion, a number of points were raised, notably:

1) City plans and policies in terms of automated vehicles will to some extent depend on the type of service that is offered by automation (e.g. private automated cars or automated shuttles).
2) The presentations during the morning session are missing a vision for the future. The focus has been on car. Is this the future we want for our cities?
3) There is a need for cities and regions to reflect on how they can use automation to serve their own transport and societal goals.
4) To be proactive as a city or region and to engage with politicians, more information is needed about vehicle automation, notably when it will be here and what are its capabilities.

The morning plenary terminated with an overview of the main themes and points that are emerging from the Polis paper on ‘AVs and cities and regions’[3].

2.1.4 Report of break-out sessions

During the afternoon session, the audience was invited to join two rounds of 3 project group discussions.

2.1.4.1 The CoEXist session

The CoEXist project conducted three exercises to elicit input from the workshop participants. Some of the key results are listed below:

1. Defining “Automation-ready”. The aim of the task was to discuss a definition of framework to enable cities to deal with the arrival of connected and automated vehicles (CAVs)
2. Vision/mobility goals. The main objective of this exercise was to ask cities about their vision and mobility goals and whether these align with the possible impacts brought by CAVs in cities
3. Identifying “automation-ready” measures. The participants were asked to define measures cities need to take over three timespans: short (0-5 years), medium (5-10 years), long term (10-15 years).

2.1.4.2 The MAVEN session

General comments about (C)AVs

Local authorities need to deal with the arrival of AVs. However, for now cities have moved from car-centric transport planning towards sustainable mobility planning, so what now is perceived as promoting car use goes against what cities are aiming to achieve. Planning for integrating CAVs

[3] https://www.polisnetwork.eu/wp-content/uploads/2019/06/polis_discussion_paper_automated_vehicles.pdf

shall be part of a bigger picture, and AVs should be part of an integrated mobility plan which considers different cultural contexts.

AVs could work only if they provide real public service. Cities need to reduce traffic, but they do not necessarily have enough public transport (PT) capacity. Improving the efficiency of AV movements will add more traffic to streets, whereas the goal is to remove cars. This is a policy question: who do we want to prioritise? It is highly unlikely that AVs will have priority over pedestrians, cyclists, and PT users

There is uncertainty with regards to competition between **AVs and public transport**. AVs can have benefits compared to PT services (e.g. in suburban and rural areas and in feeding PT hubs). Automated mass transit is very different from conventional PT, but individual automated cars are not different from traditional cars. Investment costs in PT are important; infrastructure investment, e.g. tramways, should typically last for 40 years. The same investment process will apply to automated public transport and it certainly should not cost more.

Ultimately, policy makers will decide on the modal split a city or region should aspire to in the future and that will determine policy on AVs. An evaluation of the AV evolution also depends on freedom of choice of users. Is it possible to offer tools to the public for co-modality? That has an impact on how we design system for AV.

Open questions

- AV planning: who is responsible, who owns the fleet? What about parking, storage, charging (assuming they will be all electric vehicles)?
- AV operations: in case of an AV ride booking, who has priority? What is the order to deal with the requests? Who defines that order? There are lots of moral questions behind these aspects, e.g. wealthier AV users can go straight and less wealthy users will have to take diversions?

Comments about (C)AVs and traffic management

Traffic and data management. No special traffic rules for automated cars are envisaged: they will be treated in the same way as normal cars. However, it is expected that automated cars will support procedures for diverting traffic easier than conventional cars, specifically where there is vehicle-infrastructure communication (i.e., C-ITS). Connected and automated vehicles (CAVs) can support other measures, e.g. intersections could be managed in a more dynamic manner and traffic managers could envisage using the road in a more flexible way, such as using traffic lanes in one direction during the morning peak, and in the opposite direction during the evening rush hour. However, the mix with traditional cars will still be a challenge. CAVs can take the green wave strategy on congested roads to a new level. Depending on how a city is able to interact with AVs will to some extent determine the efficiencies that can be gained.

A world of (C)AVs might rely heavily on artificial intelligence in the future. Yet AI struggles to make sense of traffic management plans given their diversity and cultural specificity. A way around this could be for traffic management centres/road-side units to communicate directly with vehicles, to influence their movements for instance. However, today’s centres simply do not have the capability to influence such a large number of vehicles and it’s questionable if traffic managers will even want to do this. There is also the question of liability, because when something goes wrong, it might be hard to determine who is responsible: e.g. the road authority, the digital infrastructure manufacturer, or the vehicle manufacturer

Open transport data is another way to have a well-connected system. There is a need to give information to cars to direct them. Traffic managers are in the best position to predict traffic, resulting for instance from big events. There is a need for sharing data between the appropriate players at the right moment: how to exchange information between the traffic manager and service providers will be key. On the contrary, a lack of data sharing will weaken the prediction of traffic flows and reduce traffic efficiency.

Responsibilities for traffic management vary from one city/region to the next and can even be shared between different agencies within a given city/region. For instance, in London, the task is shared between the boroughs and the strategic transport authority Transport for London.

Open questions raised by the participants:

- Who is responsible for the vehicle-generated and who has overall ownership of data?
- Will the traffic management be capable of dealing with the large amounts of data generated by tomorrow's vehicle?
- What is the procedure in case of system failure?
- How does an AV interact with a traffic management centre?

Specific feedback about MAVEN Transition roadmap:

The objective of this Roadmap is to be a discussion and position paper that addresses the management of intelligent and highly automated vehicles in cities in general, the role of traffic management and its level of guidance at various phases of the transition more specifically. Furthermore, it presents important considerations, and steps to be taken by road authorities, standards development organisations and other stakeholders. The following questions were asked to gather input for the roadmap:

- Do we need to adapt the infrastructure to AVs or should it be the other way around?
- Public acceptance: is there enough trust in technology?
- How will liability be addressed in a future of CAVs?
- How to make systems sufficiently robust to prevent hacking?
- MAVEN should also look at use cases where people want to get out of an AV, e.g, parking.
- How scalable is the MAVEN approach?
- The project's roadmap should limit itself to traffic management only and go deeper in one topic
- Clarify the ICT infrastructure requirements (e.g, 5G network)

2.1.4.3 The TransAID session

In the TransAID breakout session the concept of infrastructure assistance for CAVs was discussed. One of the aims was to identify circumstances and situations which require or justify the involvement of digital infrastructure and/or restrictions set by road authorities. In both rounds most of the debate focussed on the capabilities of CAVs (in general, by brand and by automation level), which seemed to result from a lack of facts on both the limitations of self-driving vehicles and their effects on traffic flow dynamics and traffic safety. This also includes our assumptions (and uncertainty) on how CAVs will behave under various conditions, as well as how drivers/monitors will behave. Without such facts a large part of this discussion remained and will remain hypothetical, which makes it hard to conclude on appropriate measures to achieve societal policy objectives.

Notably, it was acknowledged that the capabilities of AVs are often seen as intelligent property, which hinders sharing information. On the other hand, some participants argued that car manufacturers will ensure that their vehicles will be able to operate adequately, or will limit the use of certain functionality otherwise (e.g. by means of geofencing). Moreover, this might be true for the more predictable scenarios, which can be captured by maps, sensors, physical infrastructure, or machine learning, but does not explain how AVs will deal with dynamic expected scenarios and unpredictable scenarios.

Another on-going debate is the trade-off between safety requirements and system performance: a vehicle which preserves large safety margins will drive in a very conservative and therefore inefficient manner. To better understand the system boundaries, it was stated that the operational design domain (ODD, see section 1.4.1) of CAVs should be better defined, also to inform the vehicle driver of the capabilities of his/her vehicle. This led to the question which variables must be used to classify an ODD for which a CAV is suited? Another perspective on this is a procedure for certification of roads for automated driving. Road authorities could have a huge role in this, in particular when it comes to policies and strategies.

Here the scope of the discussion became much broader than traffic operations and extended to urban mobility and land use. The presence of a control centre for automated vehicles was mentioned, one that is similar to air traffic control and may support automated vehicles depending on their capabilities and classification (certification) of the road. In addition, it was stated that decentralised control could assist and manage AVs in a more pro-active manner thereby improving their performance. This concept is very much related to the TransAID vision.

Related to this it was stated that also the coexistence of automated vehicles and manually driven vehicles should be assessed in more detail. Finally, the involvement of city representatives in the global CAV debate was stipulated: when CAVs will be introduced based on the needs of cities (cities pull) and not because of technology readiness (technology push), it will become a city-guided development which will lead to different requirements. Here we note that cities need to obtain a clear view on what they want to achieve, as they are more concerned with mobility in general rather than just CAVs.

2.1.5 Implications to TransAID work

It was not possible to identify specific circumstances and situations where infrastructure assistance for CAVs is most needed, as the workshop participants did not (yet) have knowledge on this subject. Nevertheless, the need for some control function was acknowledged and therefore worth exploring. This requires more evidence as well as a policy framework. These might be obtained/derived from modelling/simulation studies (involving academics) and field experience (involving car manufacturers).

2.2 TransAID-INFRAMIX stakeholder workshop, 9 October 2019, Graz

2.2.1 Scope and aim of the workshop

In addition to networking, the joint stakeholder workshop, due to the high diversity of attendees (see next section) was a perfect opportunity for fruitful discussions and for generating feedback on key topics of the two projects. Also, the exchange of information between the two projects was regarded as very profitable. The main objectives of the workshop were:

- Explore in more detail how increasingly automated vehicles are likely to behave in various traffic situations and how this may affect the traffic management task.
- Provide insight into the role that communication technology (as part of the digital infrastructure) can play in the shorter term of connected transport and the longer term of automated transport.

- Promote reflection among public, knowledge and technology stakeholders on proposed solutions, and on their role and responsibilities as automated driving evolves.

The workshop consisted of plenary sessions in the morning and afternoon with in between two breakout rounds. The plenary sessions were also used for digital questionnaires within the scope of the two projects.

TransAID workshop site: https://www.TransAID.eu/organised-events-workshop3/. INFRAMIX workshop site: https://www.inframix.eu/joint-stakeholder-workshop-of-inframix-and-TransAID/.

2.2.2 Workshop participants

At the workshop there were 39 participants, which comprised a very international audience as can be seen in the graphic below. Due to the location in Graz, Austria, the majority of attendees was Austrian; however, more than half were international guests, a considerably high percentage.

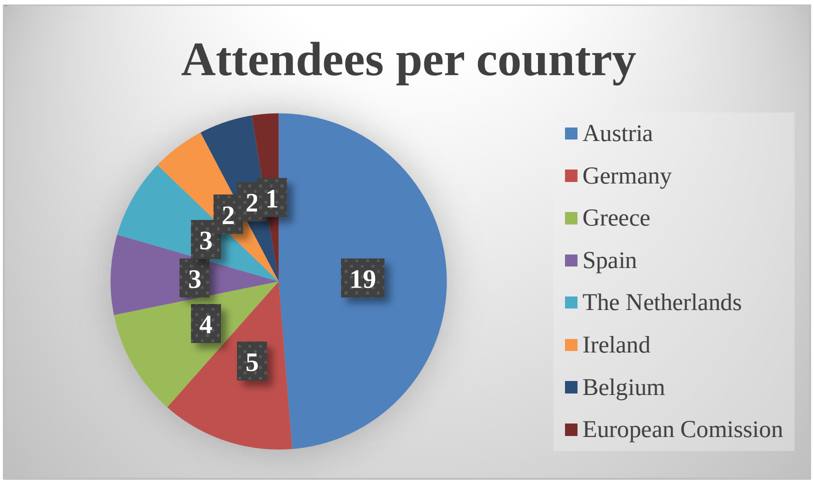


Figure 5: overview of workshop participants by country

The attendees' affiliation was also very diverse as can be seen in Figure 6. The list comprises a cross section of important stakeholder groups from e.g. Industry, Research and Government (Road Authorities). This ensured valuable input and laid out a base for interesting discussions in the breakout sessions.

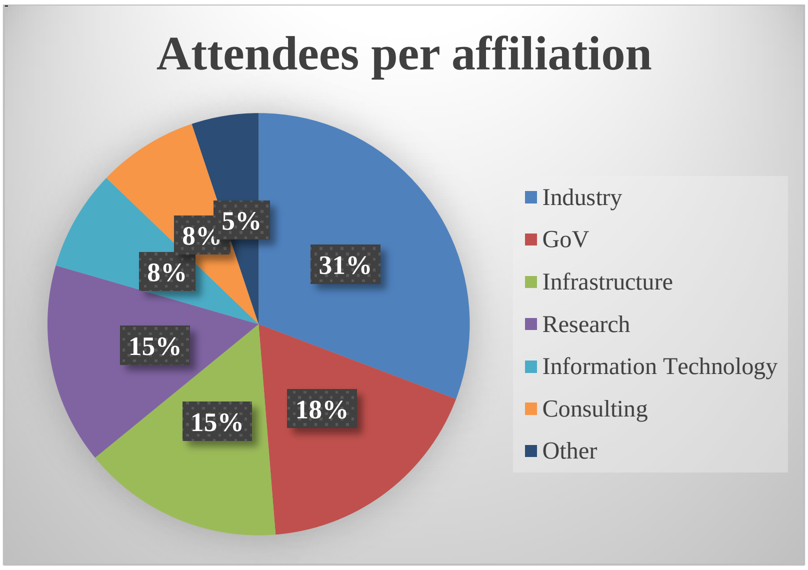


Figure 6: overview of workshop participants by sector

Figure 7: group photo of the participants

2.2.3 Report of plenary session

There were two plenary sessions, one in the morning and one in the afternoon, which were split by two rounds of break-out sessions.

2.2.3.1 Morning plenary session:

The morning plenary session was devoted to an introduction of the two projects in order to outline the main goals and approaches of INFRAMIX and TransAID to those parts of the audience who might not have been familiar with them.

- Welcome & introduction – Eva Hackl (ASFINAG) and Aldo Ofenheimer (VIF)

- Research programmes and strategic research directions – the European Perspective – Rafal Stanecki (DG MOVE)
- INFRAMIX project – Wolfram Klar (ATE)
- TransAID project – Julian Schindler (DLR)
- Expectation towards automated driving – Sven Maerivoet (TML)

The opening introduction was given by Mr. Ofenheimer from Virtual Vehicle (as Virtual vehicle hosted the workshop at their facility) and by Mr. Stanecki of the European Commission. Mr. Stanecki's presentation gave an insight on the EC on the H2020 projects and on the general view of the EC on important traffic and transport topics of the future.

Figure 8: picture of the workshop plenary room

2.2.3.2 Afternoon plenary session:

The afternoon plenary session was used on the one hand to present a wrap up of the breakout groups, on the other hand for some more questionnaires. The INFRAMIX project is required to collect user appreciation on their scenarios, therefore Mr. Wimmer gave a short introduction of the scenarios (a follow up on the presentation of Mr. Klar in the morning). The audience was then asked to fill in a digital questionnaire. Furthermore, there was a second Mentimeter session, which is described in an extra section (2.2.5) in this report.

- Breakout sessions – second round
- Wrap up of breakout sessions by session moderators – Eva Hackl (ASFINAG)
- Presentation of the three INFRAMIX use cases – Yannick Wimmer (ASFINAG)
- Interactive discussion – Sven Maerivoet (TML)
- Meet the testing group – Yannick Wimmer (ASFINAG), Daniel Tötzl (SIEMENS), Stefaan Duym (BMW), Alexander Frötscher (ATE)
- Closing remarks – Eva Hackl (ASFINAG)

2.2.4 Report of break-out sessions

Late in the morning and in the beginning of the afternoon, there were two rounds of 4 breakout sessions. The sessions were the same both rounds with different participants. The summaries below cover both rounds.

2.2.4.1 Session A - Limitations of automated driving – ODD, ToC

The break-out session was held by Alexander Frötscher (AustriaTech) from INFRAMIX and Julian Schindler (German Aerospace Center DLR) from TransAID.

In both sessions, the idea and meaning of Operational Design Domain (ODD, see section 1.4.1) was explained. While INFRAMIX is working in well-defined ODDs, TransAID focusses on the respective ends of ODDs and possible extensions using C-ITS infrastructure solutions. For example, there are TransAID services available, which intent to guide connected automated vehicles through areas where vehicle automation is challenged, e.g. in road works or on complex intersections (See Deliverables 2.1 [2] and 2.2 [3] for further information).

As digital and physical infrastructure comes into play both in INFRAMIX and TransAID, one of the key questions of the session was addressing the issue whether an ODD should be defined OEM-internal, without sharing it with anyone, or if the ODD needs to be defined commonly, so that the infrastructure can guarantee e.g. automation readiness independent of the OEM. On top of this, it has been discussed which parts need to be included in an ODD definition, and to which granularity.

Both parts of the workshop were visited by people from academia, industry, operators, and cities. While the first part was dominated by a single OEM, the second part was dominated by cities. Therefore, the discussions were quite different: the first part very much showed that the definition of an ODD is very complex and has a lot of parameters, especially on the sensor side. Here, numerous parameters may be defined, including sensor capabilities but also environmental aspects like direction of light, glare, reflection of materials, fog conditions, etc. Therefore, it was deemed to be impossible to have a common definition which would be valid for all vehicles independent of the sensor setup.

In contrast, the second break-out-session was having much more city focus since no OEM representative was in the room. During this discussion, the necessity of having a common understanding of the ODD was stressed. Cities expressed high interest in getting insights into the ODD restrictions of the OEMs and to define criteria for ODDs. The aim of this is to be in the position of allowing vehicles of different automation capabilities to use specific roads and to be able to control the use or number of automated vehicles in certain areas. As – being a lesson learned from the first break-out-session – the number of parameters for the common definition of ODDs may be too large, it has been agreed that focusing on driving capabilities instead of sensor capabilities would be helpful. Here, it could be helpful to develop AV readiness-related classes of infrastructure. Instead of defining low level parameters for each sensor, the classes should formulate more abstract scenarios, like “the automated vehicle is able to follow the road equipped with clearly visible road markings at day time and sunny weather conditions in urban areas with low buildings”. Of course, descriptions like that currently leave a lot room for interpretation. But the abstraction in general leads to state that the OEMs at the end of the day are responsible to have sensor setups in their vehicles which guarantee driving in the defined contexts of the classes. Further discussions of course are necessary to get a more complete definition of all aspects of such classes and to get such classes developed.

For TransAID, it is very important to foster such discussions, as the TransAID measures will impact those parts of the road, where ODDs of several vehicles end. Therefore, it is a mandatory criterion to understand where those areas are. The TransAID services nevertheless are not bound to specific parameters of ODDs, but offer solutions for different ODD-related shortcomings, e.g. by saying that there are "no-AD-zones" on the road where vehicle support from the infrastructure is needed.

2.2.4.2 Session B - Modelling infra-assisted automated driving and simulation findings

Selim Solmaz (Virtual Vehicle Research Center) from INFRAMIX and Evangelos Mintsis (CERTH) from TransAID presented (sub)microscopic traffic modelling approaches with respect to connected and automated driving (CAD) during parallel Session B. TransAID focused on modelling the motion of connected and automated vehicles (CAVs) (i.e. car-following, lane changing, gap acceptance and downward control transitions) in the microscopic traffic simulator SUMO, while INFRAMIX introduced a co-simulation framework (VSimRTI & ICOS) that allows the simulation of real vehicle dynamics and Advanced Driver Assistance Systems (ADAS) functions (i.e. virtual vehicle or coupling actual vehicle(s) with simulation) in a microscopic traffic simulation environment. Challenges pertaining to modelling of CAD in microscopic traffic simulation tools were subsequently discussed with the session's participants.

Initially, car-following behaviour of CAVs was examined in the context of cut-in situations induced by legacy vehicles. The majority of the participants deemed that CAVs (even of lower automation levels) could handle these situations in automated driving (AD) mode (CAVs could resume in AD mode even after emergency braking events), and should be modelled as such in simulation tools. It was agreed that lane change behaviour of CAVs can be expected more conservative (in terms of safe gaps) compared to manually driven vehicles. However, in order to avoid increased heterogeneity in mixed traffic conditions (legacy – automated – connected and automated vehicles) (C)AVs could be developed to adopt a human-like approach in terms of lane changing. Nonetheless, determining human-like lane change behaviour (which may vary according to several different factors) might be a rather challenging task[4]. With respect to modelling/simulating control transitions and minimum risk manoeuvres (MRMs), the participants argued that drivers should be allowed to take-over vehicle control during MRMs, but the vehicle should always be guided to a safety harbour (side-street location) to prevent safety-critical situations on the mainline lanes (e.g. rear-end collisions due to stop in lane after MRM).

It was also discussed that the level of detail required in modelling CAD depends on the scope of each study. Thus, modelling of actual vehicle dynamics is required when testing individual ADAS functions on a vehicle basis, but the simulation of mixed traffic streams can be conducted with lesser detail when it comes to the vehicle/driver models due to resource constraints. Moreover, it was pointed out that new traffic rules should be adopted with respect to CAD, to enable (C)AVs to cope with certain situations (disobeying existing rules might be even necessary in safety-critical situations). Finally, the session's participants agreed that traffic separation (based on automation capabilities) should be mainly warranted according to the penetration of (C)AVs in the fleet mix.

2.2.4.3 Session C - Traffic control strategies for mixed traffic

During both rounds the session was moderated by Anton Wijbenga (MAPtm) and Michele Rondinone (Hyundai), both from TransAID. A presentation was given to introduce several topics about which several questions were posed to the audience. During both rounds there were 9 different stakeholders present from several backgrounds (i.e. universities, companies such as Intel and Siemens, and road authorities such as POLIS and Rijkswaterstaat).

[4] Also see: https://www.mobileye.com/responsibility-sensitive-safety/

The objective of the session was to get a common inter-stakeholder view on TransAID measures and an understanding on their advantages and possible associated risks. Below a summary of conclusions and/or additional questions is given.

- Limitations of- and restrictions to AD:
    - How an automated car can distinguish static situations (e.g. idle vehicle will not move) from dynamic ones? A solution could be AI (or rather machine learning) to recognize vehicle types/number plates and possibly the situation/ context to provide more insights. However, it is expected that will not completely solve the problem because those machine learning models will learn by examples and have limited reasoning capabilities which cannot solve every situation.
    - VRUs must be considered and taken into account when considering AD restrictions (i.e. no AD zones) imposed by the infrastructure (e.g. school zones).
    - What if digital infrastructure systems are down and enforcement is given by human operators (police, traffic regulator)? AVs might not be able to cope with such situations because it cannot recognise the instructions from the operator, hence a Transition Area emerges.
- The new role of Traffic Management in the era of AD: measures, risks/opportunities, vehicles support:
    - The TransAID approach and 5 services are positively received by road authorities (RWS and Rotterdam).
    - Most scenarios are very dynamic. There is a need of increasing infrastructure capabilities (sensing, computing and communications) to take the most advantage of TransAID measures in a dynamic way.
    - It would require big efforts to digitalise road infrastructure and to handle dynamic (traffic management) schemes. Due to the effort, there might not be a positive return of investment in urban scenarios. Therefore, it makes sense to start on motorways and then consider applicability to urban roads.
    - In the future, dedicated lanes for (C)AVs should be considered as an incentive for AD introduction to reach long term goals of safety/efficiency. However, due to possible reduced capacity (blocking a lane for remaining traffic), it is best to use dynamic assignment which considers the traffic composition.
- Trust, safety, liability, legal aspects:
    - For traffic management to be efficient, infrastructure must be <u>authorized</u> by road authorities to provide advices (that brake traffic rules) also in a fast dynamic way or be <u>mandated</u> for recurrent situations.
    - An intermediary service for implementing the TransAID measures as conceived by the project was positively received by the audience (see TransAID D4.1 [4]).
    - Road authorities or operators could assume liability for traffic management procedures. It is happening regularly already today and it could apply to the TransAID measures.
    - More dynamic situations are those that can create most problems from the liability point of view (roadworks vs. intersection & vehicle sensing).
    - From a liability point of view, it is better to provide information than instructions. The decision of finally adopting /implementing an advice lies at the vehicle side, and therefore the responsibility as well.
    - Finally, whoever has liability can be different case by case. There is the need of a governing framework for decision making.
- Legal frameworks and current implementations of traffic measures sometimes limit the advantage of technical development. Need to adapt traffic rules for automation (Intel

Mobileye RSS is trying to establish discussions on that[5]). For example, to differentiate speed/relevance areas for different categories of vehicles.

2.2.4.4 Session D - ISAD – how can infrastructure support automated driving?

During both rounds of the breakout session, Stamatis Manganiaris (ICCS) presented the INFRAMIX ISAD (see section 1.4.2) approach to the audience. The topic raised great interest, and the session was well visited both times with approx. 15 participants in each of the sessions. Below are the highlights of both sessions:

- The necessity for infrastructure classification is strong since it will promote the cooperation between critical ITS stakeholders. It can be seen as an essential requirement for smooth and efficient ITS development.
- The ISAD classification is a dynamic work with many interactions and further discussions are needed. Especially, but not limited to, with respect to HD maps.
- A detailed specification is needed in terms of automated functionalities.
- Governance Models (Global or Local) and a Regulatory Framework are topics of great importance, since liability and (cross-countries) management issues are complicated and undefined.

Figure 9: pictures of the break-out sessions

2.2.5 Stakeholder survey results

In this section, we give the main results from a survey polled using the Mentimeter[6] platform with the audience. We asked our questions during two different moments, one in the morning and one right after lunch. The results were then aggregated, analysed, and discussed before closing the workshop. At the beginning of each question session, participants logged in to a specific website using their phone, tablet, or laptop. Then a series of questions was, one at a time, shown on the main

[5] https://www.mobileye.com/responsibility-sensitive-safety/

[6] https://www.mentimeter.com

screen, as well as their own devices. The answers to these questions provided some feedback on the work done by the project till that time and collect insights for future work. TransAID used the extensive list in Appendix C of TransAID's Deliverable D2.2 and selected some of the more prone questions to pose to the present audience.
The detailed, slide-by-slide results can be found in Appendix B.

2.2.5.1 First session results

Some 30 people attended the workshop, and about a third of the audience came from research/academia, with the rest evenly split among consulting, industry/OEM, road operator, public authority, and other. The first session contained 12 questions.

Question #1	What is your background / organisation (be as specific as possible)?
Results	1. Consultant → 8% 2. Industry / OEM → 12% 3. Service provider → none 4. Road operator → 15% 5. Public authority → 15% 6. Research / academia → 38% 7. Other → 12%

Question #2	When do you expect SAE L4 vehicles to become mainstream (motorways)?
Results	2 out of 3 people expected this to happen from 2035 onwards.

Question #3	When do you expect SAE L4 vehicles to become mainstream (urban environments)?
Results	The vast majority (9 out of 10 people) answered 2040 or later, with half of the audience even stating 2050 or later.

Question #4	How do you expect V2X communication to be adopted?
Results	About 3 out of 4 assumed this to be done through deployment by OEMs, with half of the people thinking through regulation of 4G/5G by OEMs and about a quarter through regulation of G5 by OEMs. *Note that we oversaw the option to select a hybrid approach.*

Question #5	Is connectivity required for some levels of automation (cf. SAE L3 and higher)?
Results	The audience answered unanimously yes.

Question #6	Should OEMs be forced to report disengagements (ToCs) from automated driving to a road authority?
Results	About 9 out 10 people think that OEMs should be forced to report disengagements.

Question #7	Should the operational design domains (ODDs) of SAE L4 vehicles be published by OEMs?
Results	About 9 out of 10 people think the ODDs should be published by OEMs. After discussion, it was clarified that the 'no' answers mainly stemmed from the fact that the ODD currently is not clear enough defined, with many attributes either unsure or perhaps even insufficient. This absence of a clear description makes defining the ODD very difficult at the moment, let alone specifying how exactly

	a SAE L4 vehicle would adhere to it.

Question #8	Who should decide whether a specific road section is within the ODD of an SAE L4 vehicle?
Results	About 2 out of 3 people believe this should be decided by both OEMs and road operators. 1 out of 5 people believes this to be decided by another authority.

Question #9	Should each infrastructure (road) element have an associated ISAD level?
Results	3 out of 4 people believe an associated ISAD level is required; there were 6 people that answered unsure, possibly because the concept/usability of ISAD levels was not fully clear.

Question #10	Should there, aside from homologation, be another official body that certifies SAE L4 vehicles?
Results	2 out of 3 people put forth the requirement of another official body, and 1 out of 4 saying this was not necessary. Some additional discussion was held regarding over-the-air (OTA) updates of a vehicle's software: would that for example change the behaviour significantly, so as requiring to have another certification per vehicle, or rather only at the OEMs side?

Question #11	Should an AV visibly show to other road users (exterior HMI) that it is in AD mode?
Results	This is a complicated issue which is not so straightforward to answer, as evidenced by half of the audience thinking yes and the other half answering no or unsure.

Question #12	What topics would you specifically like to discuss?
Results	1. 4G/G5 or G5? 2. Business models? 3. Certification and verification? 4. How to deal with every OEM having its own MRM solutions? 5. How and by whom the decision is made, which SAE level is allowed on a specific road section? 6. How to implement the scenarios? 7. How to keep the infrastructure databases updated? 8. Infrastructure costs? 9. Mixed traffic flows with less than SAE L3? 10. New role of road operators? 11. Public transport aspect? 12. Relation between ISAD and SAE levels? 13. Road markings? 14. Simulation approach on MRMs? 15. Stress level for non-drivers? 16. Tele-operations? 17. Testing in real conditions? 18. Traffic manager's role? 19. Urban use cases? 20. User perception? 21. VRUs?

2.2.5.2 Second session results

We had the following 11 questions during the second session.

Question #1	Would (C)AVs be allowed to ‘break the law’ in order to behave as all other road users?
Results	The large majority (3 out of 4 people) answered yes, depending on the context. A small group of 1 out of 10 people answered negatively, stating that there should in principle never be a reason to break the law when this kind of vehicles are on the road.

Question #2	Should non-automated vehicles be informed when AV in their vicinity behave differently in order to optimise traffic flows / create safer conditions?
Results	The results to this question were quite mixed, with a slight majority preferring yes versus being unsure. The question led to a discussion on who would decide for this optimisation process to occur, and how and to what degree it would affect vehicle behaviour and traffic flows.

Question #3	Who is responsible in case used map data is incorrect and leads to a dangerous situation / accident?
Results	Less than half of the people answered that the map provider is at fault, but the large majority stated being unsure. Their reasoning was that it depends on, e.g., how and where the contractual agreements are made, preferring rather to rank the results as opposed to only be able to choose a single option.

Question #4	Do you expect that AVs will be more conservative in terms of lane change behaviour compared to CAVs?
Results	2 out of 3 people answered positively to this question, with the remaining group being equally divided over no and unsure. The detail behind their reasoning was the topic of a separate discussion session.

Question #5	Do you expect that SAE L3 AVs will be able to cope with road works in automated mode?
Results	About 2 out of 3 people assumed no, with the remainder being equally divided over yes and unsure. Their answers reflected and highlighted the expected state of evolution of SAE L3 AVs.

Question #6	Are road authorities allowed to give advice that will conflict with traffic regulations?
Results	Here the large majority (4 out of 5 people) answered yes, seeing as this is one of the main responsibilities of road authorities.

Question #7	SAE L3 is considered unsafe from an HMI perspective by some; should authorities forbid those vehicles?
Results	As there were not many dedicated HMI-experts present in the audience, the large majority was unsure, with about a quarter of the people stating no.

Question #8	Should motorways have dedicated AV lanes while we are in a transition period?
Results	This question invited a lot of debate, with the end results being an equal split between yes and no, and a small group of 1 out of 5 people being unsure.

	In other sessions it was concluded it depends on the share of AVs w.r.t. the total number of vehicles because of capacity utilisation.

Question #9	What are typical causes for unplanned handovers when considering initial SAE L3/4 automated systems:
Results	For this question, people would like to have picked multiple options. As they were only allowed to choose one, 'Heavy rain and other adverse weather' came out on top as selected by half of the people. Next were 'Roadworks with reduced lanes' and 'Missing road markings'.

Question #10	What should an SAE L3/L4 vehicle do if it cannot continue its route (queueing at a blocked off-ramp, prohibited from turning at an intersection)?
Results	Here the majority of the people (4 out of 5 people) voted in favour of rerouting.

Question #11	What do you think are the most important issues (3 max) to solve during the next decade?
Results	A mixture of results was provided:

2.2.6 Implications to TransAID work

The TransAID approach and 5 services were positively received by road authorities. However, they pointed out that there is a need of increasing infrastructure capabilities (sensing, computing and communications) to take the most advantage of TransAID measures in a dynamic way. All stakeholders fully agreed that connectivity is needed for higher levels of automation. In addition, it would require big efforts to digitalise road infra and dynamic (traffic management) schemes. Due to the effort, the services might not be feasible in the short term in urban scenarios. Therefore, it makes sense to start on motorways and then consider applicability to urban roads. *Note: TransAID focusses specifically on urban scenarios.*

In the future dedicated lanes for (C)AVs could be considered as an incentive for AD to reach long term goals of safety/efficiency. However, due to possible reduced capacity (blocking a lane for other traffic), it is best to use dynamic assignment which considers the traffic composition. This aspect is more related to INFRAMIX than TransAID, however, at the beginning and end of dedicated lanes there is a likelihood for a transition area which could need some form of support measures.

One cannot expect that AVs will solve all possible situations in the future via algorithms and/or machine learning. The ODD will always have limitations for the foreseeable future. Defining this ODD is very complex, has a lot of parameters and it is necessary to create a common understanding of the concept. Cities expressed high interest in getting insights into the ODD restrictions of the OEMs and to define criteria for ODDs. Some form of ODD should be shared between road authorities and OEMs. The definition of the ODD should be a joint effort.

Regarding vehicle modelling / simulations aspects, it was agreed that lane change behaviour of CAVs can be expected to be more conservative (in terms of safe gaps) compared to manually driven vehicles. However, in order to avoid increased heterogeneity in mixed traffic conditions (legacy – automated – connected and automated vehicles) (C)AVs could be developed to adopt a human-like approach in terms of lane changing which is a big challenge.

With respect to modelling/simulating control transitions and minimum risk manoeuvres (MRMs), the participants argued that drivers should be allowed to take-over vehicle control during MRMs, but the vehicle should always be guided to a safety harbour (side-street location) to prevent safety-critical situations on the mainline lanes (e.g. rear-end collisions due to stop in lane after MRM).

Finally, the topic of liability and regulation was brought up a lot. It was acknowledged that there is the need to adapt traffic rules for automation, for example, to differentiate speed/relevance areas for different categories of vehicles. In addition, infrastructure must be authorized by road authorities to provide advices (that possibly break traffic rules) in a fast dynamic way or be mandated for recurrent situations.

2.3 TransAID final event, stakeholder workshop, 2 July 2020, online

2.3.1 Scope and aim of the workshop

The third TransAID stakeholder workshop was held on the 2nd of July 2020 as part of the TransAID final event. Originally, the stakeholder workshop would have taken place at the Urbanism Next European Conference in Rotterdam (https://europe.urbanismnext.org/). However, due to the COVID19-pandemic this conference was postponed while simultaneously the TransAID final event became an online event, therefore it was decided to devote a part of the final event to stakeholder engagement.

The aims of the stakeholder workshop were to disseminate project results to relevant stakeholders (cities and other public authorities, OEMs, industry, and academia), discuss deployment aspects of proposed TransAID services, identify further stakeholder needs, and validate TransAID recommendations. The workshop was divided in three sessions with three topics: digital infrastructure, remote management, and operational design domain & road classification. Each session aimed to be result-based to be able to offer consolidated view, and speakers were instructed to speak in a positive tone, focus on knowns as opposed to unknowns, and not repeat discussions or statements from previous workshops.

For more information about the complete final event, please refer to TransAID deliverable D9.5: TransAID Final Event [5]. Workshop materials and presentations can be downloaded from: https://www.TransAID.eu/final-event/

2.3.2 Workshop participants

The workshop was attended by 49 participants out of 88 persons that had registered. About three-quarter of the participants represented research, academia, or consulting, 7% represented OEMs and the remainder of the participants were not classified.

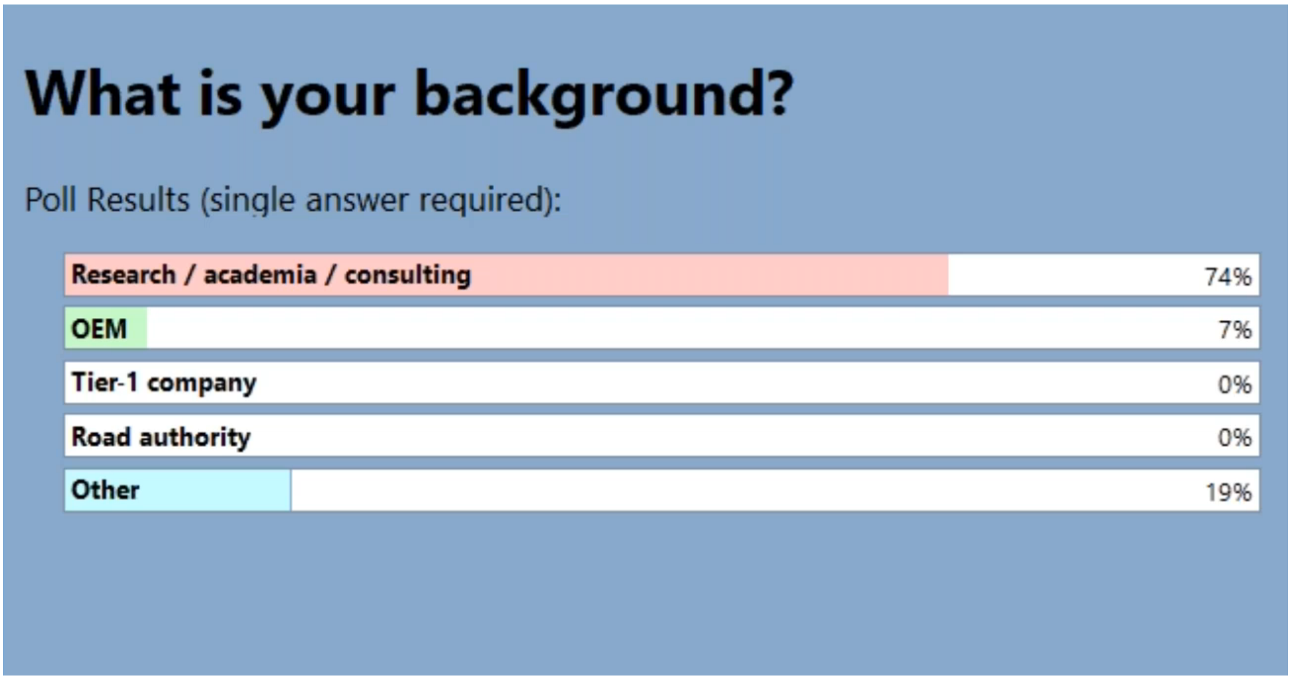


Figure 10: background of the stakeholder workshop participants

GoToWebinar was selected as the meeting platform because it has an integrated feature for running interactive polls and in that way collect feedback from the participants. The meeting platform indicated that an average about 75% of the participants responded to the polls. In addition, the participants were stimulated to post comments and questions through a questions box which the moderator would read out and the speakers could answer. All participants were deliberately muted to avoid uncontrolled debate and adhere to the time schedule. However, during the discussion parts of the workshop it was possible for the participants to request to be unmuted. The participant response received during the workshop is discussed in the next sections, but unfortunately was very limited.

2.3.3 Report of the plenary session

To offer an attractive program and reduce the risk of webinar fatigue, the workshop was divided in three sessions, each session starting with a brief topic introduction (5 min.), followed by two short presentations from invited panellists (2x5 min.), polls questions to engage the participants (5 min.) and sufficient time for discussion based on pre-defined propositions and questions from the audience (20 min). Each session is briefly summarised below.

Session 1: Digital infrastructure

Topic introduction: In a sense traffic management can become more complex as more stakeholders get involved. Rather than just a classic approach, whereby (local) authorities manage their roads, we now encounter an ecosystem where intelligence and sensor information also reside in the vehicles. Automated communication between road users and the infrastructure becomes a prerequisite for enhanced traffic management, making the systems more performant by targeting (cooperative/connected and/or automated) vehicles individually.

TransAID moderator: Sven Maerivoet, Transport and Mobility Leuven

Invited panellists:

- Mikael Ivari, City of Gothenburg and Polis, Chair of Traffic Efficiency Working Group
- Jacqueline Erhart, Asfinag

Mikael Ivari presented a local road authority perspective to digital infrastructure and lessons from Gothenburg and POLIS. He showed an example of a national road database and the information it contains and explained how local traffic regulations can be digitised and then made available through end user services. Considering the scale of Europe, he stipulated that cities across Europe vary greatly in terms of readiness of digital infrastructure and that procedures for updating information are often lacking. The key challenges for cities are the available budget versus cost and the need for expertise and processes. On the topic of road vehicle automation and cities, POLIS previously published a white paper which is available online.

Jacqueline Erhart gave an overview of physical and digital infrastructure as deployed and operated on motorways in Austria today, and how this will be upgraded the coming years with advanced infrastructure services. She gave several examples of advanced traffic management using digital infrastructure such as road work information, platooning support, and collective perception.

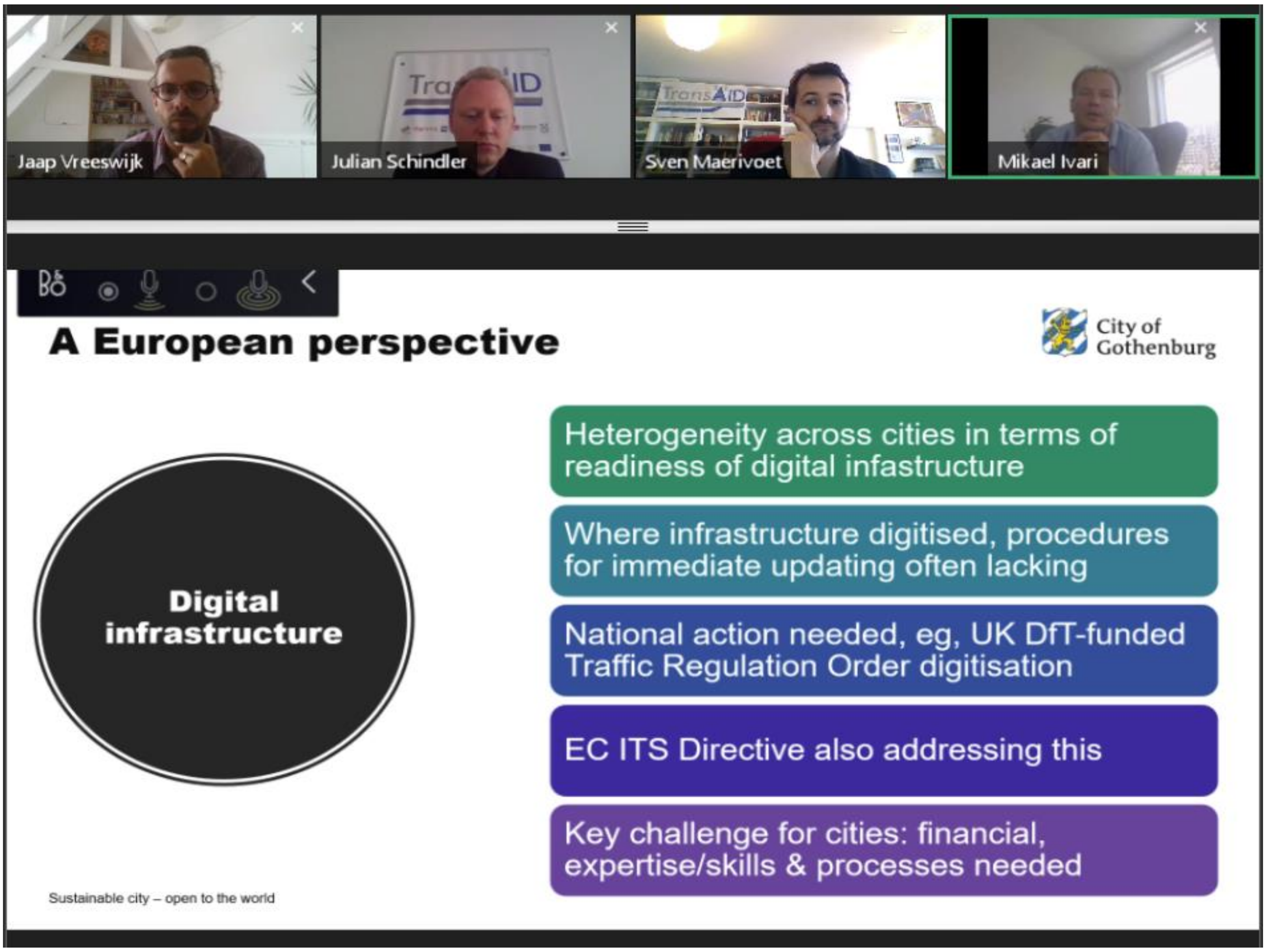


Figure 11: impression of the first session

The discussion was structured based on the following discussion statements:

1. All infrastructure should be managed by a (third) party that also communicates with the vehicles.
2. V2X connectivity is required for any L4 automated vehicle.
3. Data from (C)AVs is ubiquitously and openly shared between all parties (which can raise the debate on security etc.).

The outcome of the discussion, which focussed on statements 2 and 3, was that connectivity is no strict prerequisite for vehicle automation in the sense that automated vehicles should have a certain level of autonomy, as connectivity cannot be guaranteed everywhere. Nevertheless, it was recognized that when available, it would greatly improve the performance and capabilities of automated driving. Regarding data sharing it was agreed that the need for data sharing is valid but use case dependent, therefore the use cases must be further defined. Moreover, different types of connectivity might be suited for different use cases, and whether information is safety critical or mandatory. Finally, it was highlighted by one of the participants that data sharing is affected by data sensitivity and GDPR, therefore data-protection by design is required to adhere to privacy protection requirements.

Session 2: Remote management

Topic introduction: For the foreseeable future, safe and comfortable L4 autonomous mobility applications in mixed traffic (i.e. without steward or fall-back on board), will rely on a remote supervisory service. These include: monitoring of functional (safety), telemetry and technical surveillance; publish information and updates to support the sense-plan-act stages of the ADS; operate digital infrastructure for infrastructure segment information and guidance, and facilitate (public and private) stakeholder interaction and manage clearance. Moreover, the presence of operators in a control room also contributes to the public acceptance of autonomous vehicles.

TransAID moderator: Jaap Vreeswijk, MAP traffic management

Invited panellists:

- Olav Madland, Applied Autonomy
- Dries Declercq, De Lijn

Olav Madland’s first statement was that technology is not a goal itself, but must be seen as a tool to develop sustainable mobility. He presented a fleet management platform that enables road owners, entrepreneurs, and citizens to operate and use an on-demand autonomous transport service. A central feature of the platform is to collect and share critical information that may affect the quality of service, enabling the appropriate actor to act.

Dries Declercq introduced a fully automated shuttle system project at Brussels Airport Business Park, which will be operated without stewards in the vehicles and fully management remotely from an existing dispatching department of De Lijn. Tasks of the remote management include: monitoring system performance, passenger communication on-board and at stations, capacity management and technical interventions (on site). It is expected to achieve economy of scale by incorporating the remote management activities of other projects at the same dispatching centre.

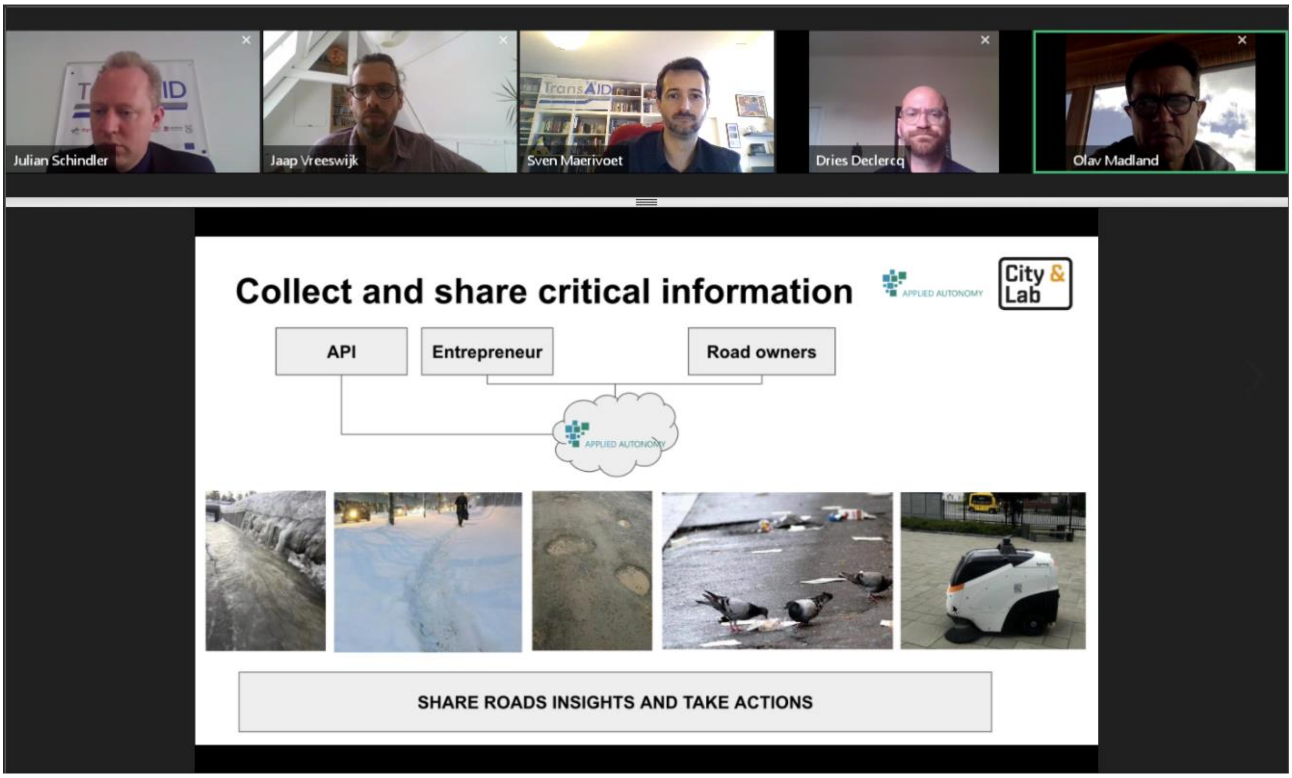


Figure 12: impression of the second session

The discussion was structured based on the following discussion statements:

4. We recommend that road authorities and vehicle manufacturers cooperate and align measures through stronger integration of *traffic management* and *fleet management*, by means of a mandated single point of access.

5. CAVs must always be intrinsically safe and remote management never takes over the control of the vehicle (i.e. remote driving). However, AD systems of all brands and makes must be able to adhere to tactical information and guidance imposed by an operator.

In addition, several questions from the audience were addressed. The first question was about the operational and maintenance cost per year of the automated shuttle system at Brussels Airport. Dries Declercq answered that a 15-year maintenance contract was awarded to the contractor and that the yearly cost is significant, but confidential. Although the cost was calculated, they need to be validated in the coming years when experience is gained with the system and uncertainties can be taken out of the equation.

A second question was about what legislation to apply to the commissioning of a remote management service. Both panellists indicated that they are working with federal government and are following existing procedures, for example to demonstrate the safety case of such a system. Olav Madland added that contingency plans need to be in place that instruct the operator how to handle in different scenarios. The topic of remote control led to some debate. The debate covered the necessity of remote driving at low speed, handling specific situations, and the integrity of the safety design of the vehicle which should not be interfered with except by an operator inside the vehicle.

The discussion led to a third question on liability in case of accidents and possible hazards. Olav Madland stated that liability resides with the one who performs the operation tasks at that moment. In case something happens, the situation needs to be assessed to determine which element in the scenario failed, for example the road, the vehicle, or the remote management. Road owners are not used to have such a responsibility, which does not mean that they cannot integrate the remote management tasks into their operational activities.

Session 3: Operational Design Domain & Road Classification

Topic introduction: Automated vehicles will not be able to cope with all possible situations. Each vehicle has its own Operational Design Domain (ODD, see section 1.4.1), specifically defining all capabilities, and limitations. Each time an automated vehicle is about to leave its ODD, it must issue a Transition of Control. To allow automated driving without Transitions of Control for long periods of driving, road authorities need to be aware of "common" ODD restrictions and related PDI requirements. Clustering the infrastructure into ISAD levels (see section 1.4.2) will help to create common rules for road and infrastructure capabilities.

TransAID moderator: Julian Schindler, DLR

Invited panellists:

- Risto Kulmala, Traficon
- Lina Konstantinopoulou, EuroRAP

Risto Kulmala presented an overview of physical and digital, and static and dynamic ODD attributes that are typically owned and maintained by road operators. As adaptations of physical infrastructure can be very costly, he emphasised the need for constructive dialogue between stakeholders. For example on trade-offs like: safe minimum risk manoeuvre specification considering also cases of very large AV fleets OR additional emergency bays, wide shoulders and safe harbours to accommodate minimum risk manoeuvres for AVs, and: uniform wear of pavement enabled by wheel path alteration in cross-section implemented by OEMs and ADS providers OR pavement design and maintenance standards review and adaption to mitigate increased roughing and rutting. As it can be understood a key issue is that ODDs are characterized by very heterogeneous attributes: from parameters that can change very rapidly according to technological evolution (i.e. advance in sensor and computation technologies), to physical infrastructure features that road operators build now to last for the decades to come.

Lina Konstantinopoulou talked about EuroRAP's star rating process which is considered to be also useful for classification of roads for automated driving. For the star rating process, a rich inventory of physical road attributes is constructed which leads to the road classification. She stated that maintenance of infrastructure will be a key factor in the AV transition phase and maintenance will become a road authority higher-priority obligation. Especially the provision of consistent signing and lining contributes considerably to a higher star rating for automated driving. Several recommendations are documented in a series of publications titled 'Roads that cars can read' which are available on the EuroRAP website. These recommendations have been applied for an audit of 25000 km of road in Australia, which revealed that freeways and highways typically have good quality lining in about 90% of the time. Based on this audit is was possible to map the classification of these roads and indicate the line quality and resulting lane confidence.

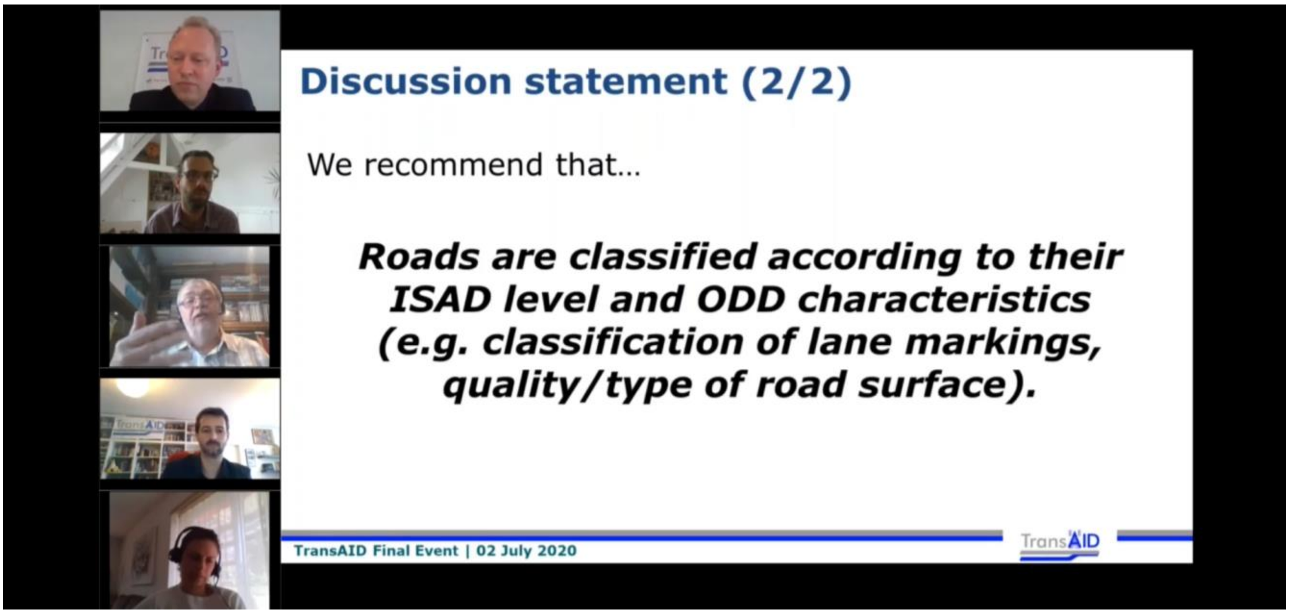


Figure 13: impression of the third session

The discussion was structured based on the following discussion statements:

6. We recommend that ODDs of all automated vehicles are shared and accessible in a common and well-defined format.
7. We recommend that roads are classified according to their ISAD level and ODD characteristics (e.g. classification of lane markings, quality/type of road surface), and that this information is shared and accessible in a common and well-defined format.

In addition, two questions from the audience were addressed. The first question was: the focus always seems to be on motorways, what about urban roads? Lina Konstantinopoulou answered that the studies of EuroRAP also showed the importance of urban road attributes like pedestrian crossings and bicycle facilities, and that for each environment the focus should be on the attributes that matter the most to ensure safe roads. Risto Kulmala added ODD requirements differ much between use cases, therefore urban use cases have their own specificities. For example, for the robo- taxi use case the presence of pick-up and drop-off bays is a crucial factor.

The second question from the audience was: can public authorities make anonymised crash data and analysis reports publicly available for improvement of concepts for AV safety? Both panellists would welcome this greatly to learn more about safety problems. For a structure analysis of crash patterns, a coherent data set is considered essential and should also include (recorded) information from the vehicle itself.

Risto Kulmala stated that the ODD may vanish due to certain characteristics that may arise. In those cases, the road operator may be in the best position to indicate that to vehicles. Lina Konstantinopoulou emphasised that EuroRAP is not defining ISAD levels, but provides information on the presence/absence of road attributes, which may service as an input for determining ISAD levels. What is important in the end is a detailed level of road information that can help to define a CAV readiness score for that particular road. That in turn may help to prioritise counter measures and thus investments. Risto Kulmala added the statement may also be reversed, meaning that road owners indicate what they can offer today and that vehicle manufacturers indicate what they need the most in addition to that. Together they can make a complete description of ODDs and road classifications. Jaap Vreeswijk complemented that there is an implicit need to also state clearly what is expected in terms of vehicle performance in certain conditions, e.g. the driving velocity, response time to an event, sensor precision, etc., as only with such indicators is possible to assess if a vehicle is able to meet the ODD.

2.3.4 Stakeholder survey results

Next to a question on the background of the participants, 12 questions were asked to the participants, 4 for each theme. Detailed survey results are provided in Appendix C.

Digital infrastructure:

1. 65% of the participants thought that hybrid connectivity is required for some levels of automation (level 3 and higher), 15% favoured ITS-G5, 15% preferred 4G/5G, and 4% was unsure. The poll shows that the vast majority of the participants think that connectivity, thus digital infrastructure, is a necessity.
2. 70% of the participants thought that CAVs 'breaking the law' in order to behave as all other road users should be allowed but regulated by context, 20% stated no, under no circumstance, and 7% was fine to leave this to the own judgement of the vehicle systems. The poll reveals that the vast majority of the participants thinks that regulation, likely to be achieved through digital infrastructure, is needed.
3. 46% of the participants thought that road authorities should NOT provide dedicated lanes for automated driving, 27% stated yes, but only on motorways, 15% stated yes, but only in urban areas, and 12% was unsure. These results show that dedicated lanes for automated driving are self-evident.
4. On the question if AD disengagements should be mandatorily reported by OEMs to the road authorities to tune traffic management (multiple answers allowed), 77% stated yes via an open standard/interface, 31% thought yes via an intermediate party, 12% though yes but with a compensation, 8% stated no and 8% unsure. Since the majority of the participants represent research / academia / consultants these results show that there is great interest in such information.

Remote management:

1. 52% of the participants thought that a CAV will stop in the driving lane or at a safe spot in case of a minimum risk manoeuvre, 33% that the CAV will drive carefully, 11% that is will initiate a handover of control, 4% that it will execute a diversion automatically. This poll shows that there are different expectations and perhaps unknowns of the consequences of minimum risk manoeuvres.
2. On the question which TransAID service for infrastructure-assisted driving the participants consider to be most realistic, 44% stated Provide speed, headway and/or lane advice, 20% thought Guidance to safe spot, another 20% thought Orchestration, distribution, and scheduling, and 16% stated Provide vehicle path information. These results reveal that traffic separation is considered least realistic and that all other services, probably with specific contexts in mind, are considered meaningful and attainable.
3. 45% of the participants thought that remote management and control is about extending the environmental awareness of vehicles, 27% choose remote driving, 14% thought mission management, and another 14% selected autopilot assistance. Extending the environmental awareness of vehicle is probably considered to be the functionality that can offer the most immediate and short-term benefit. Whether or not an operator should be able to drive a vehicle remotely is a frequent topic of debate, therefore the relative high share of votes in this poll is remarkable.
4. 50% of the participants stated that remote monitoring and control centres should be owned and operated by road authorities, 21% thought fleet owners, another 21% selected qualified entity, 4% stated vehicle manufacturers and 4% stated other. This poll shows that road

authorities are considered to be an important stakeholder in the domain of remote management of automated vehicles. The qualified entity was framed as a neutral third party that can balance the interests of all other stakeholders mentioned in this poll.

Operational design domain & road classification:

1. 73% of the participants thought that ODD definitions of vehicles should be openly accessible, 23% stated confidential and only accessible for specific entities, and 4% choose confidential and only accessible for the OEM/Tier-1. This poll reveals that the ODD information is considered desired, probably to accelerate research and development activities, but also sensitive from the perspective of manufacturers.
2. On the question what ODD definitions should be used for when they are openly accessible (multiple answers allowed), 82% stated traffic management measures, 59% thought road access control, 50% choose road network developments, 32% selected lane access control and 9% stated other. The response to this question shows that the participants have several uses in mind for the ODD information when it is available, in both the domains of planning and operations.
3. 48% of the participants thought that ODD definitions when openly accessible, should be shared by using a centralised database of vehicle capabilities, 44% stated by constantly broadcasting capabilities using communication, and 8% thought by retrieving information off-line from the OEM. What is remarkable about the response to this question is an almost equal and relatively high share of votes for two alternatives which are very different in practice.
4. On the question how cities/road authorities should best use their budget for automation readiness, 42% stated equip road/intersections with communication technology, 35% choose equip roads/intersections with sensors to enhance efficiency, 12% selected categorise roads according to ISAD levels, and another 12% stated enhance the quality of roads. This poll shows that the majority of participants favoured investing in road equipment for data collection and connectivity, in other words to increasingly digitise infrastructure, which throughout the stakeholder workshop and beyond is often considered a no-regret measure.

2.3.5 Implications to the TransAID work

The aims of the stakeholder workshop were to disseminate project results to relevant stakeholders (cities and other public authorities, OEMs, industry, and academia), discuss deployment aspects of proposed TransAID services, identify further stakeholder needs, and validate TransAID recommendations. Due to the COVID19-pandemic the stakeholder workshop had to be organised as an online meeting, which limited the amount interaction with participants. Nevertheless, by inviting panellist from outside the consortium and by means of interactive polls it was possible to receive feedback on three of the themes that have been addressed by the TransAID project.

Overall, the findings and feedback are very similar to previous events. The work of the TransAID project is generally considered relevant and needed, and the results are perceived as valuable. Yet, there remain many aspects that need to be further studied in the future, simply because field experience and field data from automated driving on public roads is scarce. A topic that was new compared to previous workshops was remote management. Especially for level 4 automated public transport (e.g. autonomous shuttles or pods) remote management seems a prerequisite to be able to deal with edge cases and transition areas, when the vehicles operate without a steward in the vehicle.

The interactive polls provided several new and relevant inputs for the closing deliverable of TransAID: roadmap and guideline. First, connectivity and digital information was again acknowledged as a necessity to match and support the vehicle technology that will gradually become mainstream on our roads. As such, investing in road equipment for data collection and connectivity is a recurring no-regret measure. Secondly, four out of the five TransAID services for infrastructure-assisted driving were considered meaningful and attainable. Provide speed, headway and/or lane advice was perceived as most promising, whereas Traffic separation is the one service that is considered to be not (or least) realistic. Another finding was that some form of regulation or external support is considered needed to allow CAVs to 'break the law' in order to behave as all other road users. Furthermore, there appears to be a general interest in a structured report of CAV disengagements, not to benchmark one brand versus others, but to better understand what factors in the operational domain affect the performance of the automated driving systems. The added value of a third-party or intermediary service, for example for remote management and the administration of disengagement reports and ODD definitions, was recognized. It is expected to generate trust among stakeholders while preserving confidentiality, contribute to harmonisation and alignment, and favour public acceptance of autonomous transport.

3 International liaison activities

3.1 TransAID-U.S. CAMP expert meeting, 25 July 2019, Detroit

3.1.1 Scope and aim of the workshop

The main goal of the workshop was to foster the exchange of information, results, and possible collaboration between the European TransAID team on the one hand, and the US CAMP team on the other hand. CAMP stands for “Crash Avoidance Metrics Partners” (https://www.campllc.org), and since 1995 is a legal structure founded by Ford and General Motors and gathering other important OEMs operating in the US market. The US CAMP is financed with 20% private funding and 80% funded by the US DOT. It provides a framework for pre-competitive research including C-ITS Solutions using V2V and V2I communications to improve real-world safety and traffic efficiency by defining and developing pre-competitive elements and accelerating their implementation and deployment. As CAMP is currently active in the project “Traffic Optimization for Signalized Corridors” (TOSCo), which deals basically with GLOSA and cooperative ACC in the vicinity of traffic lights, this was the ideal frame for exchanging knowledge.

After an initial introduction, the workshop’s discussions were held around the following presentations:

- From connected manual to cooperative automated driving: the EU automotive roadmap for V2X
- Overview of CAMP activities
- Management of CAVs through transition areas and signalised corridors
- V2X solutions for infra assisted automated driving
- Cooperative and Automated Driving: from modelling and simulation to prototypical implementation and testing
- CAMP TOSCo approach and results

Mutual discussions led to a better understanding of both groups’ activities, while it offered an opportunity to interview vehicle manufacturers.

3.1.2 Workshop participants

From the US CAMP there were about 12 participants, coming from various OEMs such as Ford, GM, Mazda, Nissan, Honda, VW, Toyota, Hyundai/KIA, Daimler, Audi, … TransAID joined with 6 members (DLR, HYU, UMH, TML, and DYN).

3.1.3 Report of workshop discussions

The US TOSCo project presented a string of vehicles that approaches a (red) traffic light and achieves a coordinated slow down / stop. When the light turns green again, or the queue advances, the vehicles enter into a so-called coordinated launch. For the moment, all vehicles in their simulations have homogeneous characteristics. TOSCo is in line with TransAID in terms of using road infrastructure for assisting semi-automated driving applications.

Nevertheless, the TOSCo approach puts much more emphasis on the development of intelligence in the vehicle (harmonized between the OEMs) to cope with any possible situations that might arise as a consequence of receiving a given type of information from the infrastructure. For example: TOSCo is using the minimum end time of the current traffic light phase to calculate in the vehicle the speed to pass with green or stop. As the vehicle does not know anything about traffic light controller plans, this might result in continuous in-vehicle recalculations as a consequence of the dynamicity of the traffic light controller in rescheduling this time. In TransAID (which follows the H2020 MAVEN approach[7]) the adopted strategy is to let the road infrastructure calculate advices based on its hierarchical “higher level” situational awareness and its negotiation processes with incoming cooperative cars (e.g., the traffic light controller can stabilise its plans and provide stable GLOSA to vehicles only when cooperative vehicles are arriving). Here, the intelligence is on the infrastructure side, the vehicle just applies the GLOSA received by the infrastructure. Hence, CAMP acknowledged the advantages of this approach and saw room for improvement of theirs if considering optimisation implemented at the infrastructure side in addition to their in-vehicle calculations.

The intent to put so much efforts on the vehicle side only (not also on the infrastructure side) can be viewed as a “conservative” approach where OEMs only implement functions based on inputs they can rely on and have full control of. Relying on advices provided by the road infrastructure and implement them as an additional control input is introducing an unprecedented scenario where it is not clear where liability might reside in case of system misbehaviour. For the same reasons, another CAMP statement was that it is reasonable to be conservative in the amount and nature of information transmitted by cars about currently supported automation levels.

It is important to stress out that the situation in Europe is quite different. Discussions on infrastructure-assisted automated driving are ongoing in the C2C-CC and C-Roads for joint strategical roadmapping[8], ERTRAC is considering infrastructure ISAD (see section 1.4.2) classification for supporting given levels of connected automated driving[9], and both OEMs and Road operators are participating in collaborative research projects on this topic.

All in all, even if the initial statement of CAMP has been as above, the CAMP participants declared not to be in the position to provide a public statement on the applicability of the TransAID approach due to the pre-competitive asset of the CAMP organisation. This means that of course a statement from CAMP may not correspond to the strategical positions of its individual members (which might or not be in favour).

3.1.4 Stakeholder survey results

TransAID posed a handful of questions to the present OEMs in order to obtain confirmation of the modelling approach adopted in its own activities. However, not all questions could be asked because the topics are considered competitive research, whereas US CAMP is more focused on pre-competitive research. In addition, the US CAMP participants were not always in the position to provide a statement on behalf of their companies. However, some individuals were approached later individually and privately in a consultation afterwards.

Generally speaking, because of the above, responses were very limited.

Question #1	Should the infrastructure provider put a limitation on the level of automated driving that it allows? (Yes, all of them/Yes, but only to some extent/No, not at all/I’m not sure)?

[7] http://maven-its.eu/

[8] https://www.car-2-car.org/fileadmin/documents/General_Documents/C2CCC_WP_2072_RoadmapDay2AndBeyond.pdf

[9] https://www.ertrac.org/uploads/documentsearch/id57/ERTRAC-CAD-Roadmap-2019.pdf

Results	No answer was given, as this is a policy business question (not yet deemed for the marketplace).

Question #2	Should OEMs explain the limitations of their automation? (Yes, all of them/Yes, but only to some extent/No, not at all/Unsure)
Results	No clear answer was given, as they stated it mainly all depends on guidelines, regulations, and even owner manuals.

Question #3	Is connectivity required for some levels of automation (cf. L3 and higher)? (Yes/No/Unsure)
Results	Participants stated that this will help, but connectivity should not be required. In addition, they estimated that traffic throughput will not be improved without communication. In any case, an automated vehicle in the absence of V2V communication is sort of a limiting factor. However, when it comes down to V2I, alignment with the road authorities is necessary.

Question #4	Should authorities forbid AVs of Level 3 and higher that are not connected? (Yes/No/Unsure)
Results	No answer was given.

Question #5	Should an AV visibly show to other road users (exterior HMI) that it is in AD mode? (Yes/No/Unsure)
Results	The participants were more inclined to give a negative answer. After asking why not, we learned that some other traffic participants (e.g., pedestrians) harass the automated vehicle (there are anecdotal stories about pestering/testing vehicles). Then, even turning the question around: do we really need to know that? There are multiple studies (EU, SAE, …) on an AV-mode indicator that give different insights.

Question #6	Would (C)AVs be allowed to 'break the law' in order to behave as all other road users? (Yes, always/Yes, but it depends on the context (e.g., safety)/No/Unsure)
Results	Interestingly, going over the speed limit would not happen (cf. the TOSCo project). Furthermore, Automated vehicles do not have and are not allowed to break the law. Interestingly, NVIDIA is looking into a generic framework for cooperative vehicle control (whereby all of them should follow the same set of behavioural rules).

Question #7	Would automated driving require the support of some sort of back-end? (Yes, OEM only/Yes, infrastructure provide only/Yes, both/No/Unsure)
Results	This was deemed beneficial, and in essence required (be it continuously or intermittently).

Question #8	What should a (C)AV do in case its route is blocked? (Ask advice from a back-end (OEM and/or infrastructure)/Execute a minimum-risk manoeuvre/Transfer control to the driver/Try to find another route (if possible))

Results	All of these were deemed viable solutions.

3.1.5 Implications to TransAID work

The value of the meeting in first instance seemed to be limited for TransAID. Nevertheless, it offered very valuable insights into the OEM universe, combined with the American perspective which is partly in contrast to that of Europe and its project landscape.

Given the nature of the discussions, it also became quite clear that TransAID is on the right path regarding its modelling assumptions, based on the ideas of a large group of different OEMs. That by itself is a very valuable piece of information, implying that the concepts that TransAID is modelling and describing are both valid and sound.

3.2 TransAID + ITS Japan / UTmobI expert meeting, 7-8 April 2020, online

3.2.1 Scope and aim of the workshop

The European Commission encourages projects to exchange results and ideas with projects in the Americas and Asia-Pacific. This international expert meeting aimed to exchange with the Collaborative Activities to deploy level 4 mobility services within ITS Japan and UTmobI. The exchange was initiated at the SIP-adus workshop 2019 during the break-out session on Regional Activities. The theme of this TransAID – ITS Japan/UTmobI expert meeting was: Operational Support for L4 Automated Vehicles and Mobility Services. The following topics were selected for discussion. For each topic one presenter from Europe and one presenter from Japan were appointed, followed by time for discussion.

- Project introductions and overview of regional activities.
- Operational Design Domain (ODD, see section 1.4.1) of automated vehicles and infrastructure support.
- I2V- based traffic management measures for cooperative automated vehicles.
- V2X communications and protocol solutions for cooperative automated driving.
- Vehicle automation modelling and simulation.
- Priority areas for future research and innovation activities.

The Delegation of the European Union to Japan kindly offered to host the meeting in the Europe House in Tokyo. Their interest was to facilitate and promote EU-Japan liaison activities on priority topics, which recently includes Connected and Automated Vehicle Technologies. However, due to COVID-19 a physical two-day meeting has been cancelled and replaced by two online meetings.

3.2.2 Workshop participants

The participants of the meeting are listed below.

Europe:

- Jaap Vreeswijk, MAP traffic management, the Netherlands
- Julian Schindler, German Aerospace Centre DLR, Germany
- Sven Maerivoet, Technology Mobility Leuven, Belgium
- Miguel Sepulcre, Universidad Miguel Hernandez de Elche, Spain

- Evangelos Mintsis, Centre for Research and Technology Hellas, Greece
- Meng Lu, Dynniq, Netherlands
- Michele Rondinone, Hyundai Motor Europe Technical Center, Germany

Japan:

- Takahiko Uchimura, ITS Japan / University of Tokyo, Japan
- Takashi Oguchi, University of Tokyo, Japan (7th Apr. only)
- Hideyuki Kanoshima, University of Tokyo, Japan
- Kazuaki Minami, ITS Japan, Japan
- Yurie Toyama, Mitsubishi Research Institute, Inc., Japan (8th Apr. only)
- Manabu Umeda, University of Tokyo / SIP-adus, Japan

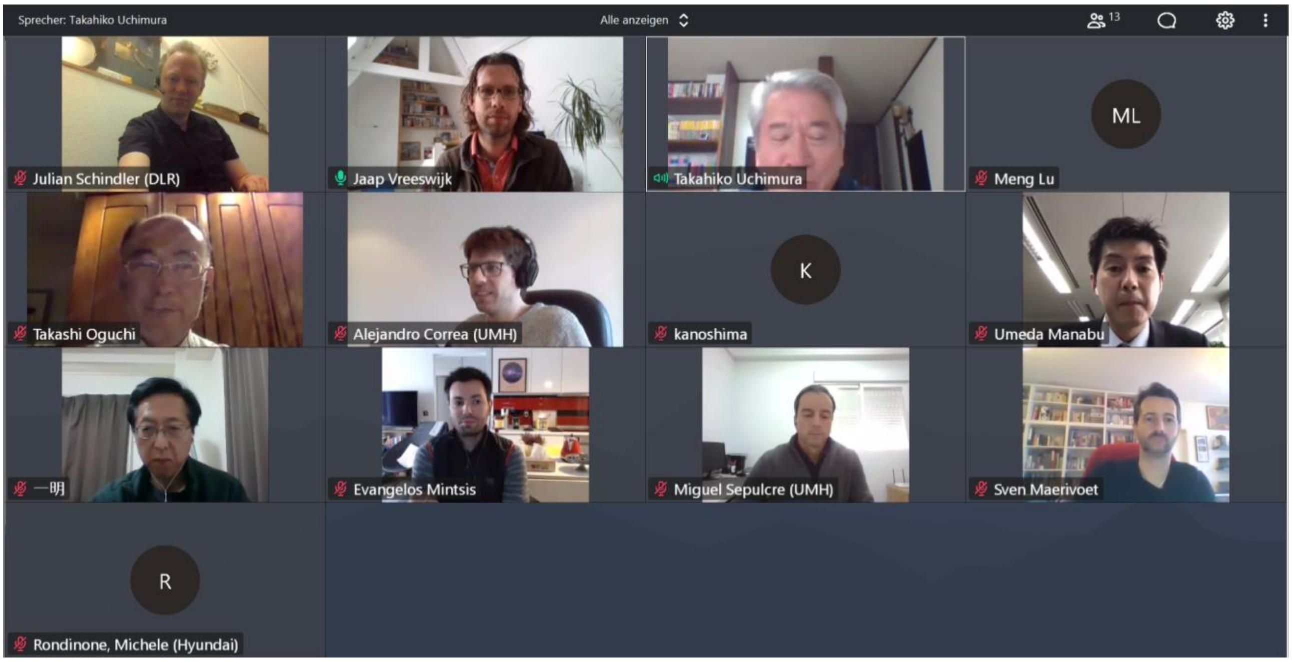


Figure 14: impression of the meeting

3.2.3 Report of the plenary session

Presentations are available at:
https://www.TransAID.eu/workshop-7-8-april-2020-europe-japan/

Project introductions and overview of regional activities

Julian Schindler introduced the TransAID project, explained the concept of transition areas, detailed the project methodology and briefly presented related European activities INFRAMIX, CoExist, MAVEN and L3Pilot.

Manaby Umeda introduced the Mobility Innovation Collaborative Research Organization (UTmobI) of the University of Tokyo and their trial activities and practical implementation of an automated shuttle bus. In addition, he presented the national research project on automated driving systems, SIP-adus. The 2nd phase of this project follows two paths to a full automated driving society. One by expanding the operational design domain of privately owned automated vehicles from highways to general public roads, another through practical implementation of level 4 logistics and mobility services. Finally, several areas for field operational tests were presented including scenarios with merging assistance, provision of traffic signal information and self-driving buses, all at the Tokyo waterfront area.

After the presentations, the participating experts clarified the definition and modelled behaviour of CAVs, the scenarios and traffic situations selected for simulation activities, and application of vehicle-to-infrastructure communication. The current state of practice is that OEMs are trying to determine the usefulness of infrastructure information for their automated driving systems.

Operational Design Domain (ODD) of automated vehicles and infrastructure support

Jaap Vreeswijk talked about managing the boundaries and gaps of ODDs, especially when there turn out to be systematic and recurring. He introduced a framework with 7 dimensions that are relevant to defining ODDs and gave two examples for the classification of roads. Finally, he explained the intermediary service concept as defined by the TransAID project and proposed to discuss the link between physical and digital attributes on the one hand and ADS functions / driving tasks on the other hand.

Takahiko Uchimura first introduced ITS Japan followed by a more detailed description of their focus on practical implementation of level 4 mobility services in suburban area, with emphasis on meeting local needs. Approval of service operation is based on the service design (e.g. vehicle specification and capability) and the operational domain in which the vehicle will operate. In this first phase, the aim is to customize the operation plan to local circumstance, including the design of the vehicle that is suitable for a particular area.

After the presentations, the participating experts briefly discussed properties of the operational design domain in different trials and deployments. Only recently, the Japanese ministry started to assess the role of infrastructure. There was consensus on the need of more information on disengagement of automated driving systems. The reality today is that each deployment of level 4 mobility services is unique as local conditions are very different each time. A certain level of commonality would be preferred, therefore UTmobI is looking for common denominators across multiple local deployments.

I2V- based traffic management measures for cooperative automated vehicles

Sven Maerivoet presented TransAID’s services to prevent, manage and distribute transitions of control and/or minimum risk manoeuvres. Thereafter he showed results from the simulation activities that aimed to assess the impact of traffic management on traffic efficiency, traffic safety and environmental impact.

Takahiko Uchimura explained that several scenes have been identified where it is difficult to fulfil the driving tasks of the level 4 mobility service, e.g. due to the route, weather conditions, presence of other road users, technology limitations or restricted system capability. UTmobI is exploring various measures to overcome such scenes, like on-road support, remote support, regional support, and infrastructure. As a result, the mobility service vehicles will be able to travel at level 4 from the start to the end of the trip.

After the presentations, the participating experts discussed if adaption of infrastructure is requirement or an option. It was agreed that solving all the infrastructure-related issues requires a very large effort, therefore the vehicles must have a minimum level of autonomy. In Japan, 5G cellular communication was used for remote driving, which sometimes proved to be not fast enough, but more experience and study is needed.

V2X communications and protocol solutions for cooperative automated driving

Miguel Sepulcre first gave an overview of the message sets that are using in the TransAID project and next explained in detail the concepts of cooperative sensing, cooperative manoeuvring and finally discussed V2X communications reliability.

Takahiko Uchimura presented first ideas on V2X communications and protocols for mobility services, assuming that the use of V2X technologies is a solution to support automated driving systems. Four use cases were presented: uncontrolled right turn with pedestrians, cyclists and oncoming traffic, communication at signalised intersections, communication for vulnerable road users, and remote operation at critical locations.

After the presentations, the participating experts exchanged several questions for clarification. Regarding vulnerable roads users, the aim of UTmobI is to try to detect pedestrians and cyclists with roadside equipment and inform them using cellular communication and smartphones. On remote driving, although some tests with 5G-networks were done (see above), the idea is to have level 4 deployments that are fully self-controlled and do not necessarily require remote driving. It is to be evaluated if this is feasible. About 5G, Takahiko Uchimura explained that 5G and not short-range communication was selected for the mobility services. The University of Nagoya is doing tests with 5G and is studying vehicle control through 5G. First results are expected to be published this year. On the question if anybody in Europe is doing real testing, Julian Schindler described the service feasibility assessment activities of TransAID and referred to the relevant project deliverable. In addition, the Hyundai-UMH demonstration video was shared[10]. It was explained that shuttle services are beyond the scope of TransAID, but that several national projects are implementing shuttle for passenger transport, including remote operation. More background was provided on the organisation of European versus national projects.

Vehicle automation modelling and simulation

Evangelos Mintsis presented the vehicle / driver models for AVs and CAVs used by the TransAID project and explained how (cooperative) lane changing, transition of control and minimum risk manoeuvres were modelled. In addition, he explained the variation of vehicle types, traffic demand levels, automation/communication penetration levels and the parametrization schemes in the different simulation scenarios and how these were integrated in the SUMO simulation software. During his presentation Evangelos showed several videos of simulation scenarios, which are also available on the project website. He concluded by giving a brief demonstration of the simulation tool that was developed by the TransAID project, which significantly eases the process of setting up a simulation scenario and processing the output.

No presentations from the Japanese side have been given on this subject.

After the presentations, the participating experts clarified details of the modelling and simulation. It was explained that iTETRIS, the TransAID simulation tool, combines modelling of CAV mobility, traffic management measures and V2X communications. Transferability of the modelling tools to slower moving mobility like automated shuttles was discussed, but experts were not sure if this is feasible without adaptation. The Japanese Automobile Research Institute (JARI) is working on simulations for passenger vehicles and they are interested to exchange best practices. They already reached out to the German PEGASUS project. For the field operational test location on the

[10] https://www.transaid.eu/videos/

metropolitan expressway in Tōkai, where similar merging scenarios are implemented as those in TransAID, no simulations are yet performed.

Priority areas for future research and innovation activities

The final part of the meeting was devoted to discussing common and different research and innovation interests in Europe and Japan. In general, it appears that Japan is more pragmatic and industry driven, with less political debate (e.g. on communication technologies) than in Europe. The following priority areas were identified:

- More (large scale) field operational tests with level 3 and level 4 automation.
- Safety assurance and vehicle approval procedures for level 4 automated vehicles deployments with remote support.
- Public acceptance of automated driving systems, including internal and external human-machine interface considerations.
- Transportation (mobility) system design including urban planning and spatial/road design, i.e. a more holistic view on mobility in the future with vehicle automation.

Questions before closing

What happens after the TransAID project is complete?

- Usually when an EU project ends, all companies and institutes go their own ways and apply project results for own exploitation purposes and research activities. Commercialization of results is also viable via several private and public means. Another scenario is that results are reused in new national or (EU-)funded (e.g. Horizon 2020 Automated Road Transport (ART) calls) projects.

3.2.4 Implications to the TransAID work

Due to the sudden replacement of the physical meeting by online meetings and the time difference between Europe and Japan, there was less time to exchange information and it was more difficult to engage in a detailed discussion. Nevertheless, both sides were able to inform each other about on-going activities and share project results. There was no disagreement or strongly differing views on any of the content that was discussed. The participating experts expressed interest to explore EU-Japan joint calls and look for other opportunities to collaborate.

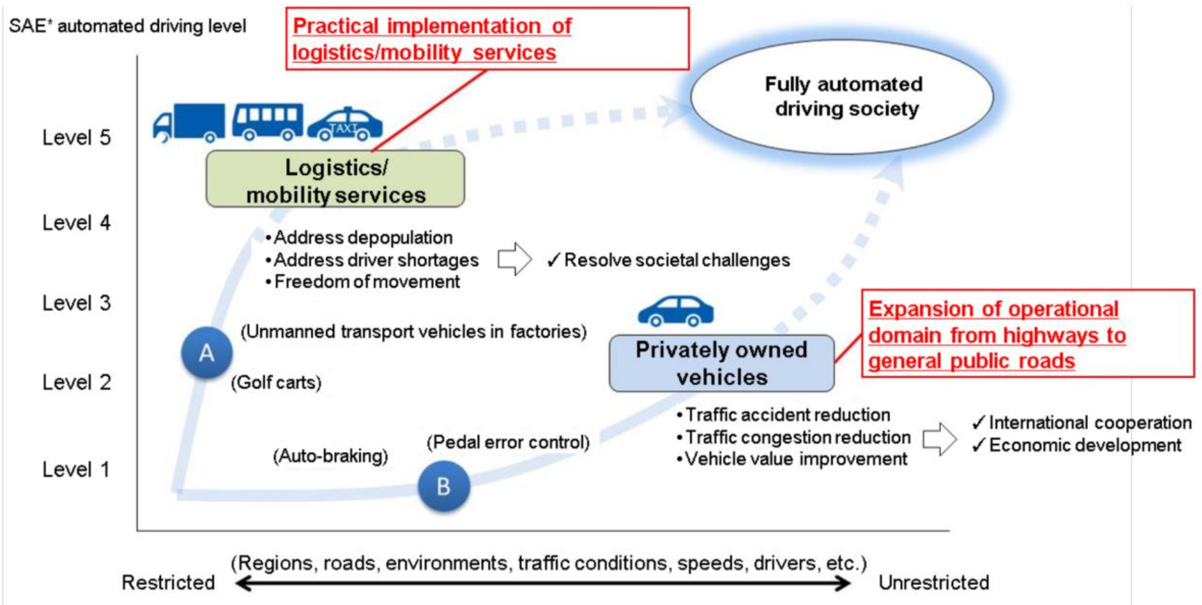


Figure 15 – pathways to fully automated driving society (source: SIP-adus presentation)

Most of interest to the TransAID project and input for the closing deliverable, the roadmap and guideline, is the Japanese perspective on pathways to level 4 and eventually a completely automated driving society. The associated figure is shown above.

The two pathways follow two different approaches, one is to expand the level of automation in an unrestricted driving environment (i.e. privately owned vehicles that become increasingly automated), whereas the other is to gradually expand the driving environment for a given level of automation (e.g. autonomous shuttles that move from segregated road to an open road with mixed traffic). Like the Japanese experts argued, the first pathway is very challenging as the automated driving systems have to meet high requirements and many situational factors and once. Therefore, the time to deployment may be long. On the other hand, the second pathway can have a very short time to deployment if the right operational domain is chosen. Moreover, remote support from either V2X equipped infrastructure or a human operator can ensure safe and reliable operation.

4 Other stakeholder consultation opportunities

4.1 TransAID session and survey, 8 June 2019, IEEE-IV, Paris

4.1.1 Scope and aim of the workshop

The TransAID session was held on June 9, 2018 in Paris, France, in conjunction with the IEEE Intelligent Vehicles Symposium (IV[11] 2019), one of the major annual conferences of the *IEEE Intelligent Transportation Systems Society* (ITSS). The Symposium was titled the "3rd Workshop on Connected, Cooperative, and Autonomous Driving", which targeted connected, cooperative, and autonomous technologies for cooperative and automated road transport. The workshop also featured an Industry Panel with experts from related industries, which fostered the interactive exchange of academia and industry.

Recent developments in telecommunications, sensor, information processing, and control technologies have enabled substantial progress in the domain of ITS. C-ITS is in a very early stage of deployment, as it is technologically achievable, but the deployment requires cooperation of multiple stakeholders. Automated driving is on the horizon, and will still need substantial and longer-term development and testing to make even the high automation levels a reality in complex situations, such as in urban environments, and in a transit period of only partial market penetration. Cooperative and automated transport are certainly complementary. They are expected to bring substantial benefits in terms of safety, comfort and (traffic and fuel) efficiency. Many challenges exist in this important domain. The workshop targeted the challenges for C-ITS applications, especially connected and cooperative systems towards automated driving. Competing communication technologies (e.g., local network (IEEE 802.11p), cellular network, and future 5G), sensor, information processing and control technologies were highlighted. The impacts of (C-)ITS applications were analysed. Requirements for strong cooperation between industry, authorities and academia in different regions were addressed.

The main conference organisers were on the one hand Dr. Meng Lu, Strategic Innovation Manager at Dynniq (The Netherlands), VP for the IEEE Intelligent Transportation Systems Society, and Steering Committee Member for the IEEE Future Networks (Enabling 5G and Beyond), and on the other hand Dr. Cristiano Premebida, Aeronautical and Automotive Engineering at the Loughborough University.

4.1.2 Workshop participants

As speakers and panellists, we targeted academia, OEMs, suppliers, ICT infrastructure providers, authorities, standardisation bodies, and other organisations. The workshop was moderated by Mr. Tim Leinmüller from DENSO AUTOMOTIVE (Germany). A detailed overview of the distribution of backgrounds can be found in the first slides of sections A.1 and A.2.

4.1.3 Report of the plenary session

The workshop was composed of three different types of interaction: survey questions, invited speakers, and oral-paper presentations. The results of the survey are reported in the next section. Below the topics of the invited speakers and oral-paper presentations is given:

[11] https://iv2019.org/

- **Invited speakers**
    - ICT infrastructure systems for automated driving (Dynniq, The Netherlands)
    - Assuring the Safety of Autonomous Vehicles (Loughborough University, UK)
    - Enabling L3 + driving through the generation of crowd-sourced maps (Continental AG, Hyundai Motor Europe Technical Center)
    - Infrastructure-assisted automated driving in transition areas (DLR, Germany)
    - Preparing the road infrastructure for the introduction of Automated Driving – the INFRAMIX approach (Enide, Spain)
    - Management of privacy in cooperative ITS (Trialog, France)
    - Connected and Autonomous Vehicle Security: Challenges Ahead for 5G (Orange Labs, France)
    - Base material for microscopic autonomous simulation (VeDeCom, France)
- **Oral-paper presentations**
    - On the topic of Connected & Automated Driving
        - In-Chamber V2X Oriented Test Scheme for Connected Vehicles
        - Optimal control based CACC: problem formulation, solution, and stability analysis
        - Infrastructure Support for Cooperative Manoeuvres in Connected and Automated Driving
        - Test and Evaluation of Connected and Autonomous Vehicles in Real-world Scenarios
    - On the topic of C-ITS
        - TARA+: Controllability-aware Threat Analysis and Risk Assessment for L3 Automated Driving Systems
        - A Test-Driven Approach for Security Designs of Automated Vehicles

4.1.4 Stakeholder survey results

We asked questions during two different moments using the Mentimeter[12] platform, one in the morning and one right after lunch. The results were then aggregated, analysed, and discussed before closing the Symposium. At the beginning of each question session, participants logged in to a specific website using their phone, tablet, or laptop. Then a series of questions was, one at a time, shown on the main screen, as well as their own devices. We used the extensive list in Appendix C of TransAID's Deliverable D2.2 and selected some of the more prone questions to pose to the present audience.

During the first session, 22 participants came from academia; one fifth were OEMs.

As some people in the audience switched workshops after lunch (the TransAID session was organised in conjunction with several others), we asked them again about their background. This time, 2 out of 3 participants came from academia; others were OEMs and service providers. The detailed, slide-by-slide results can be found in Appendix A, including the exact numbers regarding the affiliation of the audience.

[12] https://www.mentimeter.com

4.1.5 Implications to TransAID work

From a perspective of dissemination on the one hand, and obtaining stakeholder knowledge on the other hand, TransAID organised its symposium together with a large existing event to ensure a higher probability of attracting people.

Given the audience of the workshop (targeting technologies for cooperative and automated road transport), it was possible to foster an interactive exchange of ideas between academia and industry.

The contents of the workshop were three-fold: there were survey questions posed via the Mentimeter platform, we had a large cross-stakeholder coverage with the invited speakers, and finally we expanded the programme with oral-paper presentations. These latter fall into two categories, i.e. Connected and Automated driving, as well as security-related aspects of Cooperative ITS. Each time an interactive discussion with the audience ensued, providing further insights into the authors' points of view.

The survey results revealed that about half of the participants came from academia. Interestingly, a large group was in favour of foreseeing areas where automated driving should not be allowed, thereby directly confirming that TransAID's research questions and approach are sound and sensible. A very high proportion of the participants also spoke out towards OEMs, asking them to explain the limitations of their autonomous vehicles. In addition, connectivity was perceived as a requirement for Level 3 or higher autonomous vehicles. To conclude, a discussion followed some of the results related to the question whether (connected) automated vehicles would be allowed to break the law. This was seen as moderately acceptable when optimisation of the traffic stream was called for, but definitely for the purpose of increasing traffic safety.

The TransAID project partners have used the workshop on the one hand to disseminate their results and gather feedback on them, and on the other hand to obtain valuable information that was used during the second iteration's simulation activities.

4.2 EU EIP workshop on ODD, 1 October 2019, Turin

4.2.1 Scope and aim of the workshop

The first stakeholder workshop on impacts of automated driving, how to maximize the benefits; was organized by the EU EIP (EU ITS Platform) with support from L3Pilot[13] and took place in Athens, fall 2018[14]. The EU EIP is the place where National Ministries, Road Authorities, Road Operators and partners from the private and public sectors of almost all EU Member States and neighbouring countries, cooperate in order to foster, accelerate and optimize current and future ITS deployments in Europe in a harmonized way. The successful setting attracted attendees from EU EIP SA 4.2, L3Pilot, automotive OEMs, equipment suppliers, telecom industry, road operators, local and regional authorities, governments, and research institutes. The workshop discussed, in a multi-stakeholder setting, the benefits of Connected Automated Driving and how the road and automated vehicle can interact through the concept of Operational Design Domain (ODD, see section 1.4.1) responsibilities. With this second workshop, the organizers aimed to bring this expertise together again, this time to explore costs and benefits around highly automated driving along with identifying the role of Operational Design Domains in facilitating automated driving.

[13] https://www.l3pilot.eu/

[14] https://eip.its-platform.eu/highlights/impacts-automated-driving-how-maximize-benefits-workshop-summary-0

The workshop aims were:

- Day 1 - Discussion on Operational Design Domains, their evolution path, and the role they can play in type approval and certification.
- Day 2 - Examination and discussion on costs and benefits of highly automated driving based upon existing research and projects.

In multiple ways the EU EIP activity 4.2 on facilitating automated driving is well aligned with the interest of the TransAID project. The objectives of EU EIP activity 4.2 are:

- Identify the requirements of higher level (SAE 3-5) of automated driving for road authorities/operators, for example road markings, traffic signs, real-time and predictive traffic information, digital maps, cooperative ITS infrastructure
- Assess the direct and indirect impacts of higher-level automated driving on traffic, mobility and the core business of road authorities and operators; investigate the socio-economic benefits and costs of automated driving from the road operator's perspective
- Provide a road map and action plan, focussing on the needs of road operators to facilitate automated driving on the TEN road network
- Identify the requirements of automating road operator ITS to facilitate automated driving (i.e. self-maintenance, self-optimisation, self-management, self-healing); and automation level of traffic centre operations and services (control/management/information)
- Monitor, liaise and disseminate, to gain better understanding in global activities, R&D, deployment, and policy development, disseminate lessons learned.

The workshop comprised of plenary and break-out (parallel) sessions. During the plenary sessions different perspectives with respect to ODDs were shared by various stakeholders (i.e. European Commission, OEMs, Road Operators, and Research Projects), while scoring costs and benefits for different use cases of highly automated driving was conducted during the parallel sessions. Detailed information about both plenary and break-out sessions is provided in the following subsections.

4.2.2 Workshop participants

Overall, 40 participants attended the workshop representing road authorities, car manufacturers, European Commission, research institutes, road operators, and consultancies. A detailed list including the names of all participants is not available, but information pertaining to invited speakers and their corresponding presentations is listed below:

- Angelo Rossini, CEO Aosta Valley Motorway, Introduction to the workshop
- Roberto Arditi, Coordinator, SINA, Introduction of the EU EIP project
- Tom Alkim (DG RTD), EC Perspective on ODD
- Luisa Andreone (CRF), OEM/L3 Pilot perspective on ODD proposal
- Risto Kulmala (Traficon), Road operator perspective on ODD proposal
- Jaap Vreeswijk (MAPtm), TransAID project: dealing with transition areas
- Pirkko Rämä (VTT), CARTRE project: scenarios and their benefits (results of the CARTRE benefit evaluation based on the four future deployment scenarios)

4.2.3 Report of plenary session

The plenary part of the first day of the workshop consisted of 4 presentations followed by a panel discussion. The focus of the majority of the plenary presentations was placed on ODD aspects. First Tom Alkim of DG RTD presented the perspective of the European Commission. An interesting part of his talk was on the annual Gartner hype cycle for emerging technologies. He showed that moving from the 2015 to the 2016 edition that the years to mainstream adoption of automated driving changed from 5-10 years to more than 10 years, while in 2018 compared to 2017, autonomous driving was split into level 4 autonomous driving and level 5 autonomous driving to acknowledge the complexity of level 5 automation. In addition, he mentioned that from an EC standpoint we are still not close to rigidly defining ODD per automated driving system. Next Luisa Andreone of CRF presented the L3 Pilot perspective and introduced 8 categories of ODD. Thereafter, Risto Kulmala of Traficon summarised the road operator perspective with material from both EU EIP and the CEDR Mantra project[15]. He stressed the uncertainty associated with ODD today, but also in the future as the ODD is likely to evolve over time. Moreover, the cost involved to adapt infrastructure should not be underestimated and first calculations were provided. Finally, Jaap Vreeswijk of MAP traffic management introduced the TransAID project while linking the project activities to an integral view on ODD and the resulting TransAID rationale (see Figure 17). He concluded his talk by summarising the assumptions and results that require validation. Finally, Tom Alkim (DG Move) elaborated on the EC policy objectives pertaining to the field of cooperative, connected and automated driving (CCAD), while Pirkko Rämä (VTT) provided information about an ex-ante impact assessment of CCAD (8 thematic areas) that was conducted in the context of the CARTRE project.

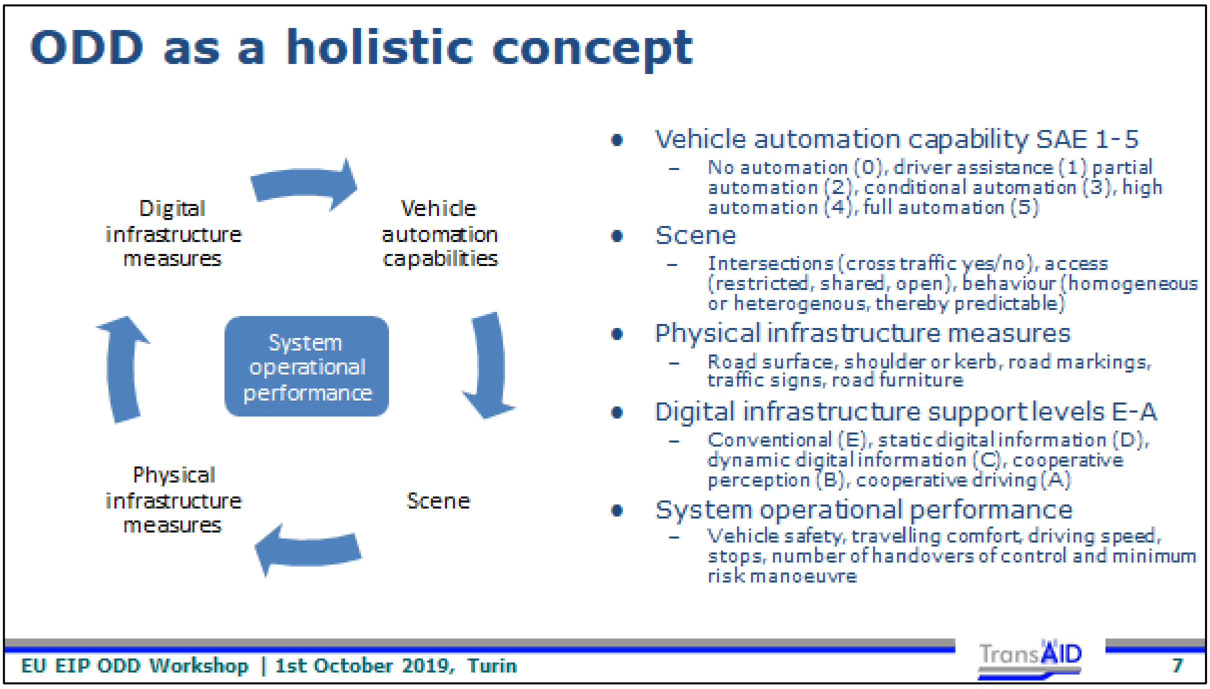


Figure 16: ODD as a holistic concept, slide from presentation

15 https://www.cedr.eu/download/other_public_files/research_programme/call_2017/automation/project_descriptions/MANTRA.pdf

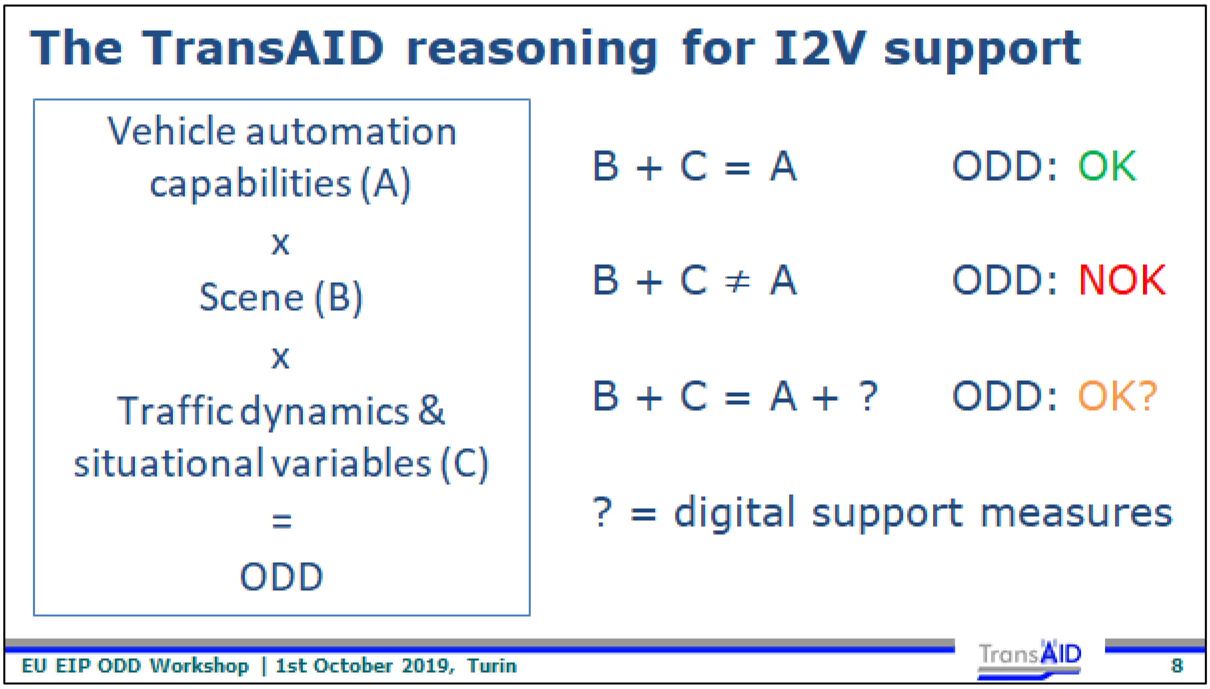


Figure 17: TransAID reasoning for I2V support, slide from presentation

In the panel one of the main topics of discussion was about the variables and their units and scales that could enable describing the ODD systematically. This would enable stakeholders to interpret the ODD unambiguously in the same way and to plan actions that could contribute to a more continuous, less interrupted ODD. ODDs should differ between different use cases and are going to be period-dependent, but they could also be manufacturer or ISAD level (see section 1.4.2) dependent. In addition, new reliability and liability issues would arise when factors and systems external to the vehicle (e.g. digital and physical infrastructure) would become an integrated and trusted part of the ODD. Moreover, roles, tasks, and responsibilities of different stakeholders, both public and private, were highlighted as an important topic. Most of these which exist today are likely to exist in the future, therefore they need to be considered in the ODD space appropriately. On the one hand this implies that automated vehicle systems might be enabled under road authority and infrastructure authorization actions, while on the other hand it must remain feasible to inform (automated) vehicle systems and regulate the movement of traffic. Finally, the interdependency of ODD attributes was discussed and there was consensus among the panel that few attributes are fully independent, which might imply that parts of operations can be/are enabled by multiple attributes and some attributes are interchangeable. In addition, it was highlighted that there is some kind of trade-off between the complexity of the vehicle environment, the vehicle ODD and the vehicle's driving performance, for example the driving velocity. Instead of assuming that an automated vehicle system is in or out its ODD, like a binary variable, the driving performance of the vehicle might be adapted in such a way (e.g. reduce velocity) that the automation system can cope with the situation at hand, therefore remains in its ODD. A few participants argued that for certain ODDs and sensor capabilities, road markings might not be required eventually. Additionally, it was highlighted that ODD cannot be currently used for type approval of automated vehicles (AVs), since the EC is struggling with permission rules.

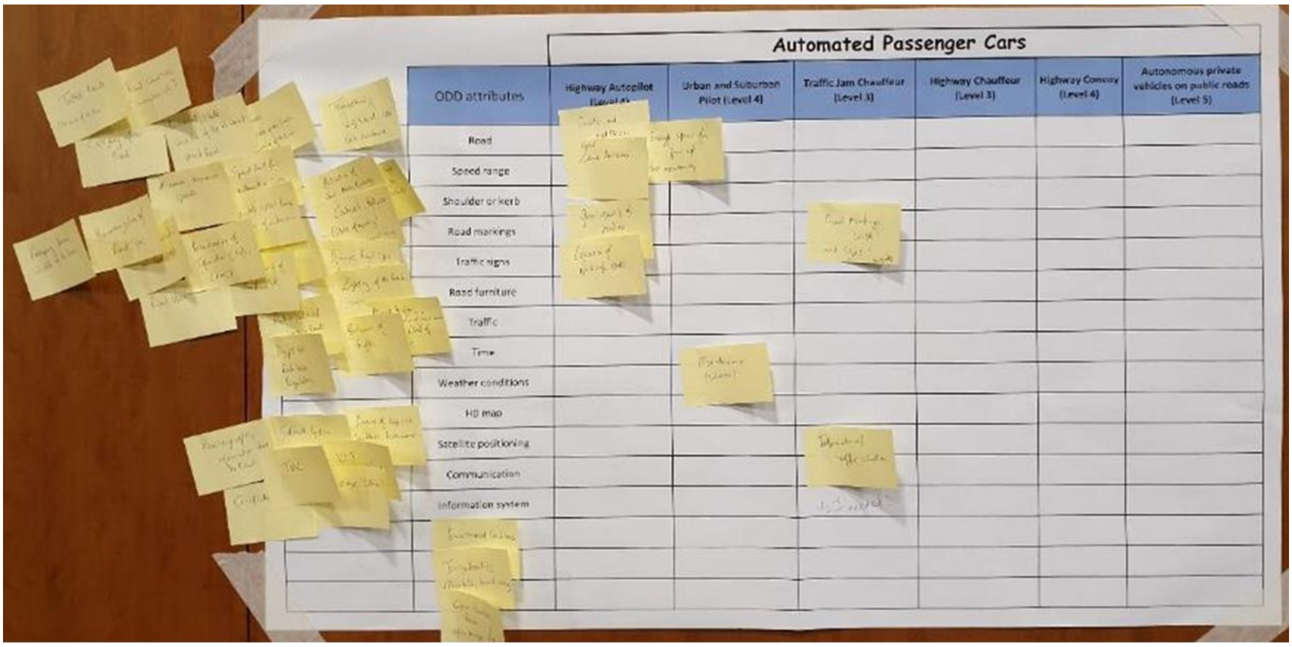
4.2.4 Report of break-out sessions

Three parallel sessions were organised based on the use case groups of the 2019 ERTRAC roadmap[16], i.e. automated passenger cars, automated freight vehicles, and urban mobility vehicles. The goals of the sessions were to: discuss the predefined ODD attribute list and whether all relevant attributes for the use case are included, discuss the requirements for the ODD attributes and identify agreements and differences among stakeholders, and identify priority attributes for evolution from the user, infrastructure provider, and industry perspectives. Below a summary of each of the breakout sessions is provided.

4.2.4.1.1 Automated passenger cars

The discussion of this group first focussed on understanding the predefined ODD attributes. This showed that there are many different perspectives to most ODD attributes and that many sub-attributes exist. Interestingly, for various attributes (see Figure 18) the discussion could go into two directions. One being the assumption that ODD attributes are requirements from vehicle automation systems to their environment to enable automation. The other being the assumption that vehicle automation systems should be capable to handle most ODD attributes, hence the attributes are a requirement to the vehicle automation system. For example, high quality road markings could be seen as an enabler of automation, but reversely vehicle automation systems must also be able to cope with poor road markings. Following the panel debate on the interchangeability of attributes, or in other words the complementarity of attributes, it was suggested that it is needed to look more closely to the level of driving tasks of the vehicle automation system as opposed to use cases. For example, longitudinal and lateral driving tasks. This would allow to better isolate the required capabilities of the automation system and to identify the functions of this system and their needs to execute the driving task. Such an approach might prevent that the importance of ODD attributes is overestimated or underestimated, which is something that easily occurred while discussing them. Finally, it was acknowledged that the precise situational and environmental conditions of the automated vehicle are very decisive when describing the ODD of use cases. This revealed an interesting balance between a desire to address specific conditions (e.g. causes for disengagement and takeover requests) on the one hand, and on the other hand the inability to be exhaustive when it comes to situational, environmental and other ODD characteristics (i.e. an infinite number of conditions). Clearly, an alternative perspective or compromise of some kind is needed here which will be taken into consideration when creating TransAID D8.3 later in the project.

[16] https://www.ertrac.org/uploads/documentsearch/id57/ERTRAC-CAD-Roadmap-2019.pdf



	Automated Passenger Cars					
ODD attributes	Highway Autopilot (level 4)	Urban and Suburban Pilot (level 4)	Traffic Jam Chauffeur (Level 3)	Highway Chauffeur (level 3)	Highway Convoy (level 4)	Autonomous private vehicles on public roads (level 5)
Road						
Speed range						
Shoulder or kerb						
Road markings						
Road furniture						
Traffic						
Time						
Weather conditions						
HD map						
Satellite positioning						
Communication						
Information system						

Figure 18: picture of the break-out poster and discussion

The objective of the “Automated Passenger Cars” session during the 2nd day of the workshop was to score (in a range scaling between -10 and 10) benefits and costs of a Highway Autopilot system (SAE Level 4 Automated Vehicle) in mixed traffic conditions. Initially, the participants agreed that Highway Autopilot can induce increased demand and vehicle miles travelled (VMT). Thus, it can be expected that congestion will worsen in the presence of the system. Moreover, it was noted that Highway Autopilot can be more conservative in terms of car-following and lane changing compared to manual driving in the absence of connectivity. Thus, capacity can reduce if automated vehicles are not connected as well. On the other hand, there is already evidence indicating that the system can stabilize traffic flow depending on the penetration rate. Centralized and decentralized traffic management can play a significant role towards the latter direction and possible ameliorate to a certain extent the adverse impacts of induced demand that will be generated by the system introduction. However, it was stressed that the required cost for the digitization, operation and maintenance of the road infrastructure can be substantially high. Traffic safety is expected to improve since automation will be able to minimize human errors, but on the other side the type of accidents can change due to heterogeneity in traffic stream, false negatives, false positives, control transitions and minimum risk manoeuvres (especially those not guiding the AV towards a safe harbour). Fuel efficiency of individual AVs will be increased but not on a lifecycle basis. Additionally, excessive demand due to automation can aggravate the negative environmental impacts of road traffic. Finally, the session concluded that social equity would improve considering the wider access of disabled people in motorized traffic.

4.2.4.1.2 Automated freight vehicles

The discussion groups that dealt with automated freight vehicles (AFVs) centred around a limited number of ‘use cases’, or more specifically, ‘environments’ for which the ODD would be discussed.

Examples of these were:

- Private terrains with only L4+ AFVs
- Hub-to-hub corridors with only L4+ AFVs
- Hub-to-hub corridors with mixed traffic
- Any road (incl. urban) with mixed traffic

The discussions started with an overview of the attributes associated with the ODDs, and to what extent they are applicable/relevant for a specific environment. Already some pertinent questions shaped the majority of the discussion. For example, is an ODD solely limited to infrastructure, or can it also encompass aspect such as weather disturbances? The debate then went on, concluding that we probably need to have the list of characteristics/attributes (digital versus physical, and static versus dynamic) to be more elaborated upon by the relevant stakeholders. In addition, discussions were less than straightforward, as we needed to define some sort of ‘frame’ under which the ODDs were valid. For example, ODDs may differ between use cases, and can even be period-dependent (2020, 2030, 2040, or even further). An interesting side-track in the discussion was about the (changing) role / relevance of lane markings, as for certain ODDs and sensor capabilities these may no longer be needed. In addition, some parts of the discussion centred on how ODDs can or even should be used for type approval of automated (freight) vehicles. Concluding that aspect, TransAID noted that currently the EC is struggling with the different permission rules, as they are dependent on the Member States and currently behind schedule. However, the SEARUB project[17] aspires to contribute in this respect.

Central to some of the use case discussions, was the notion of mixed traffic situations, e.g., to what degree does mixed traffic modifies an existing ODD? No clear answer was found. And in addition, the discussion also tried to include the costs and benefits of certain (traffic management) systems, after which the main debate revolved around which stakeholders (i.e. road authorities versus the private sector) should make which investments.

As it stood, most of the available time for the breakout session was spent on just trying to explain the attributes, as they were perceived as being not clearly enough defined and subject to various interpretations. In hindsight, it could have been better if the specifics of each attribute were uniquely identified, perhaps in a separate session, before them being used in a discussion, even though most of the attributes are very use case specific, even too specific to ambitiously address them all in a breakout session. There were also high dependencies between various attributes, e.g., flow vs. travel time/speed vs. safety (of whom?), etc.

[17] https://www.tmleuven.be/en/project/searub

In addition, the uses cases themselves were not clearly defined enough to have a good, fruitful discussion about. What is understood by ‘mixed traffic’? How much is it mixed? Where do the different types of vehicles drive? Etc. Because of this, again a lot of time was spent in trying to (re)define the use case, so that everybody would be on the same page. However, this went at the cost of sacrificing the finer points of coupling each attribute to each use case, for which we felt not enough time was remaining available. Furthermore, the absence of a critical mass of OEMs made the discussions not always straightforward, at which point the group had to resort to its own assumptions on certain vehicle behaviours (which would have a big effect on the supposed impacts). The danger is that this can create a mismatch, possibly leading to policy makers drawing the wrong conclusions.

4.2.4.1.3 Urban mobility vehicles

A discussion was held during the “Urban Mobility Vehicles” session to identify differences in requirements with respect to the operation of Automated PRT/Shuttles on dedicated roads/lanes and in mixed traffic. Initially, the organizers of the session clarified that dedicated lanes do not necessarily mean physically separated lanes by the rest of the road infrastructure. The participants also debated about the inclusion of robo-taxis in the “Automated PRT/Shuttles” vehicle category, but eventually it was decided that the discussion will be dedicated explicitly on shuttles. The session did not reach a consensus on the identification of specific road types where Automated PRT/Shuttles could preferably operate (especially in the case of dedicated lanes), but it was highlighted that infrastructure maintenance (e.g. road kerbs, stops, lane markings) is crucial for the correct operation of the service. Traffic signs were considered rather important for the mixed traffic scenario (especially to notify manually driven vehicles), but maybe also necessary for the dedicated lanes cases due to regulatory/legislative reasons. It was also stressed that Automated PRT/Shuttles should be able to perform tactical manoeuvring (e.g. obstacle avoidance and overpassing) in mixed traffic, since they currently run on pre-specified routes and explicitly stop in lane when safety critical situations are identified. Another aspect that received attention during the session was that of extreme weather conditions. The participants agreed that the shuttles should not operate in such occasions since stopping the service while in route will negatively impact its reliability and popularity. However, it should be expected that the Automated PRT/Shuttles should be able to function safely in regularly bad weather conditions. Finally, it was deemed important that an information service is available (especially in the case of mixed traffic) to warn the Automated PRT/Shuttles about downstream hazardous situations and provide guidance in the case of complex traffic situations.

4.2.5 Implications to TransAID work

It was valuable to present the TransAID project activities, vision, rationale, and points of discussion to an audience that is equally active in this domain. The topic of the Operational Design Domain (ODD) of automated vehicles seems to be a common denominator for many activities, or at least a topic that focusses the debate and converges the discussion. Moreover, it was valuable to engage in more in-depth discussions on the ODD topic specifically with stakeholders and representatives of other projects. However, the presence of vehicle manufacturers was sincerely missed, which is a point of attention for future workshops. This workshop was mostly useful for validating the appropriateness and relevance of the TransAID work and to further structure our thinking on a roadmap and guideline to plan for traffic management with vehicle automation. For example, the holistic framework (see Figure 16) to enable automation that was prepared for this workshop will be further developed based on the feedback that was received, and the next version will be used as input for the next workshop(s).

4.3 International workshop on ODD, 22 October 2019, Singapore

4.3.1 Scope and aim of the workshop

The title of the workshop was: constructs of the Operational Design Domain (ODD, see section 1.4.1) of Automated Vehicles. Any automation use case of level 1-4 is usable only in its specific ODD, thereby an ODD can be very limited, for instance a segregated road or a single fixed route on low-speed public streets. The attributes of the ODD are directly connected to the way the automated driving system works and the interaction with its environment. In this session, known information about the ODD and the factors constructing it was presented. In addition, it was discussed how automated driving can be facilitated through measures – vehicle technology, (digital) infrastructure-related and otherwise – that help preserving and extending the ODD.

One of the objectives of the workshop was to create a place to discuss authority/industry roles in development and deployment of Automated Driving Systems and ODD. It was an invitation-only gathering to ensure high level of expertise. It was setup as independent and informal exchange of information and views. The intended outcome of the workshop was a joint illustration of the common understanding of the interaction ‘vehicle – infrastructure – regulation – use area’, related to ODD.

4.3.2 Workshop participants

The workshop had 32 participants and about 15 persons more interested but unable to attend. The participants had a diverse background including policy makers, road operators, industry, vehicle manufacturers, research institutes and independent safety assessors. Organisations and countries were include the following: MAP traffic management, the Netherlands; Asfinag, Austria; Path Berkeley, United States; Ertico ITS-Europe, Belgium; Traficon, Finland; Keio University, Japan; European Commission, Belgium; Trafikverket, Sweden; Toyota Research Institute, United States; Rijkswaterstaat, the Netherlands; ITS Japan / University of Tokyo, Japan; ANDATA, Austria; SB Drive, Japan; Nanyang Technical University, Singapore; TÜV SÜD Asia Pacific, Singapore; Transcore, United States; Aurora Snowbox Oy, Finland; Finnish Transport Infrastructure Agency, Finland; Mitsubishi Research Institute, Japan; CSiS / University of Tokyo, Japan; Highway Industry Development Organisation, Japan; Ministry of Land, Infrastructure, Transport and Tourism, Japan.

4.3.3 Report of plenary session

The workshop was moderated by Jaap Vreeswijk (MAP traffic management, the Netherlands), representing the TransAID EU-funded project. There were four speakers from the EU, US, and Japan.

- Welcome, workshop introduction and objectives, self-introduction by participants
  Jaap Vreeswijk, MAP traffic management, the Netherlands
- Why ODD is fundamental to driving automation systems and how infrastructure can facilitate driving automation
  Steve Shladover, PATH, United States
- ODD management and integrated communication systems
  Hironao Kawashima, Keio University, Japan

- Infrastructure support classification
  Jacqueline Erhart, Asfinag, Austria

- Attributes of the ODD. Summary of a multi-stakeholder workshop on ODD, cost and benefits of automated driving (1-2 October ’19, Turin)
  Risto Kulmala, Traficon, Finland

Figure 19: picture of the workshop plenary room

Jaap Vreeswijk briefly introduced the workshop topic with a graphic that was derived and elaborated from previous workshops and discussion (e.g. see previous chapters in this deliverable). The graphic is shown in Figure 20. It shows 7 dimensions of ODD, which aims to illustrate coherence, interrelation, and causality among these 7 aspects related to vehicle automation systems and ODD.

Steve Shladover offered his view on ODD definition and ODD attributes. He gave an overview of different forms of infrastructure support: physical protection, electronic/information support, and good infrastructure design and maintenance. Regarding ODD classification he summarised the complexity by referring to an ‘infinite variety of possibilities’ and ‘N-dimensional tensor’.

Hironao Kawashima talked about ODD management to safeguard the provision of equal services to all, which includes orchestration, location tracking and communication systems. In his view ODD management focusses on the improvement of traffic management under mixed conditions.

Jacqueline Erhart presented a scheme for Infrastructure Support Classification referred to as ISAD levels (see section 1.4.2). She argued that infrastructure provides ODDs and can offer support to close ODD gaps. To achieve this, physical and digital infrastructure elements are required.

Risto Kulmala gave an overview of ODD attributes which were categories such as physical or digital, static, or dynamic and by stakeholder responsibilities. In addition, he talked about estimated cost for each of the attributes and referred to 'cost elephants' to raise awareness for the considerable cost involved. Finally, he stated that ODD evolution means added uncertainty to road authorities.

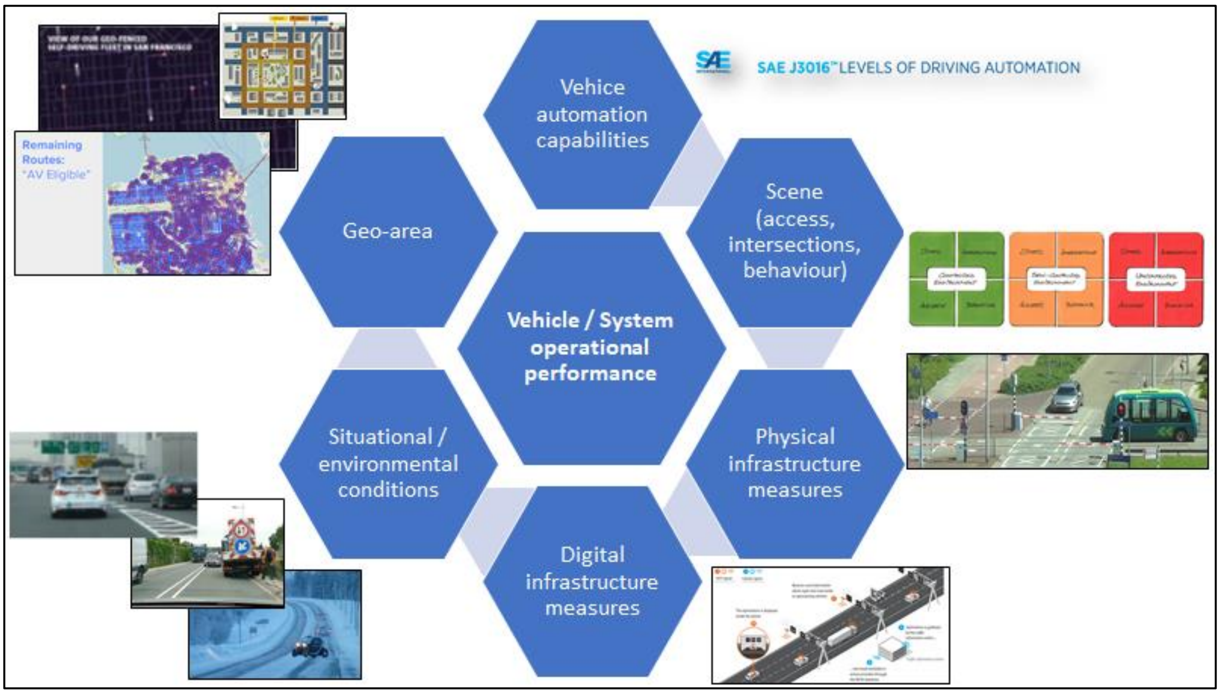


Figure 20: graphic to illustrate the coherence, interrelation, and causality of 7 aspects related to vehicle automation systems and ODD

4.3.4 Report of break-out sessions

Three break-out groups were held, each addressing a slightly different perspective. In general, the task was to approach ODD and vehicle automation system from the infrastructure side and define categories of infrastructure support that would enable different levels of automation. The three break-out groups addressed the following topics.

Figure 21: picture of the workshop break-out sessions

Topic 1: ODD continuity and coverage – what will be the minimum risk state when the ODD ends, and to prepare for this, at which points, areas and situations are infrastructure/remote support services most relevant, as seen by both the automation system providers and infrastructure owners and operators. Findings from this session are:

- To have a meaningful discussion on CAVs (expected) behaviour it is important to go beyond the level of automation and describe the functionality (e.g. difference between shuttle, personal vehicle, and robo-taxi).
- Large part of the discussion was on the Minimum Risk Manoeuvre (MRM).

- Can be an abstract discussion to argue whether MRM is part of the ODD or not…
- Anyway, MRM needs to be defined and this cannot be done in an absolute manner (one MRM for all possible scenarios).
- The MRM is context dependent, there may be a whole range of acceptable MRMs depending on both the actual situation (context) and the available information (contextual awareness).
- Most discussions on acceptable behaviour of CAVs assume perfect knowledge of the context (also in ethics discussions and moral dilemmas), but often this is not the case in reality. Example: a possible acceptable MRM could be to swerve around an object, but only if that path is clear, so you need to know location and planned trajectories of other traffic participants. If you do not, is swerving with a chance to hit something or someone, preferred above stopping?
- There is also a difference between expected and unexpected transitions of control, MRMs in case of failure to take over may be different for both cases.
- Future work/research could be to identify what elements to take into consideration to describe an MRM and the context.
- It should also be discussed from which perspective to formulate acceptable MRMs and which stakeholders should have a role in that. Industry, authorities, road operators, consumers, etc.

Topic 2: How different kinds of infrastructure features or modifications could make it easier for the automation systems to recognize and respond to all relevant hazards, and how are roles and responsibilities allocated among stakeholders (who should do what). Findings from this session are:

- Each Automated Driving System (ADS) has its own level of automation and capability to interact with other road users under different conditions. How do you determine what kind of support is needed from the infrastructure under each situation? This will depend on the sensory and V2X communication capabilities of the ADS in the vehicle.
- To explain the situation understandably, ODD and infrastructure support will have to be considered. Infrastructure support could be physical and/or digital (information).
- Physical side is expensive, but digital part is less expensive. Try to limit the dependence on physical infrastructure because of the cost. Digital support costs less to implement, but is still challenging to operate and maintain at reasonable cost.
- The ODD should be defined by ADS developers based on the technical capabilities that they have been able to verify. Authorities would like information from ADS developers about what they need to do on specific roads to provide support, but developers are not going to provide that information. They have been mapping roads on their own with their service providers (e.g. HERE for German OEMs) so that they will be able to have more extensive ODDs than their competitors.
- There are however different levels of data to be considered. Data from public authorities (like provided by TN-ITS - https://tn-its.eu/) is trusted data. There are several open data sources too.
- The approach should be to focus on the next 20 years, when we have to look at the high-level roads. After 20 years, if the high-level roads are well served, we should extend to lower levels of roads. But users are likely to want continuous operation. How to include municipalities?
- We need to prioritize what we can afford to do.

- The ODD limitations of each ADS must be understandable for the customer.
- Singapore is focusing on automated public transit and mobility on demand. Governments can dictate which are their desired levels of automation and areas of operation. ADS developers must demonstrate how they can serve these desires. Governments can modify infrastructure under certain conditions. It is however much easier to provide infrastructure support in new cities, where the infrastructure can be designed from the start to support ADS needs.

Topic 3: The role of infrastructure/remote support capable of supervising automated vehicles, the need of different infrastructure services and the required redundancy of external infrastructure elements to design functional safe CAV systems. Findings from this session are:

- Automated driving and automated mobility will not be supported in every environment. Since the ecosystem of vehicles, roads and community may vary, every stakeholder in this ecosystem focuses on different benefits of the transport system, e.g.:
  - The automated orchestration of public transportation has benefits for the general community while the individual city mobility may decrease.
  - The orchestration of mixed traffic including individual automated mobility has the opportunity to improve traffic efficiency.
  - While in other regions, infrastructure will prohibit automated mobility and focus more on conventional physical mobility like cycle areas.
- Thus, the interaction of autonomous vehicles and the traffic system has to be considered from different perspectives: vehicles have to take the final decision in every driving manoeuvre. In case of a fallback or degradation of automation level, the interaction of the vehicle system with the road has to be defined. The physical and digital infrastructure can support vehicles, although the definition of redundant vs. complimentary sources of information for automated mobility has to be negotiated between roads and vehicle manufacturers. ISAD defines only the willingness of infrastructure to support AVs with different services. The trade-off of improving vehicle sensor systems and upgrading the infrastructure is still to be better understood. There is no clear and common picture on the requirements of public transport mode and of individual vehicles. While the lifetime of infrastructure investments is long-term and need to consider the evolvement of automation levels within the next decades, the role of infrastructure in the CCAM ecosystem has to be discussed and business cases have to be defined.

4.3.5 Implications to TransAID work

Based on the moderator reports in the closing plenary session a set of recommendations could be derived, which offer a summary of the discussion and are useful input for the TransAID final deliverables like the roadmap and guideline.

In a plenary closing session, the break-out group moderators gave a briefly summary of the discussion and the participants were able to respond. Some highlights from this discussion is summarised in the bullets below.

- ODD limitations must be understandable for the consumer.
- ODD should be defined by ADS developers (or assessment and certification institutes), based on verifiable technical capabilities.
- Reluctance to share needs and information due to ODD competition; more extensive ODDs than competitors.

- ODD attributes: requirement from ADS to environment that enables automation OR conditions that the ADS should be able to handle.
- Interchangeability/complementarity of attributes (technologies) as seen from the perspective of driving tasks (e.g. lateral & longitudinal control) and ADS functions (e.g. perception).
- Expectation on driving skills and performance of ADS must be validated.
- Focus on separate driving tasks, the underlying AD functions, and their needs. Be cautious not to overestimate the importance of ODD attributes.
- Desire to address specific conditions vs. the inability to be exhaustive in terms of ODD characteristics vs. confidentiality. Shareable abstraction level needed.
- Roles, tasks, and responsibilities of stakeholders that exist today are likely to still exist in the future, therefore are part of the ODD.
- Infrastructure and operators perceived as possibly unreliable by OEM's.
- AD bus in mixed traffic (JP): 'infrastructure and regulation made it possible'.
- Remote supervision and support preferred to remote control.
- Try to limit dependence on physical infrastructure because of cost.

4.4 Joint dissemination of H2020, CEDR projects and other initiatives related to CAVs and Infrastructure, 3 March 2020, Brussels

4.4.1 Scope and aim of the workshop

The deployment of Connected and Automated Vehicles (CAV) is a critical issue for the mobility of tomorrow. Pending questions on the capacities of Cooperative Connected and Automated Mobility (CCAM) to improve mobility for all, reduce road space demand and enhance safety, heavily depend on the cooperative and proactive action of public and private stakeholders, to steer development and effectively prepare for the transition phase, defining where and how CCAM is rolled-out, the types of services and behaviour implemented, and its impacts on road infrastructure.

With this in mind, CoEXist has taken the initiative to organise a workshop, led and coordinated by FEHRL. The event, called "Joint dissemination of H2020, CEDR projects and other initiatives related to CAVs and Infrastructure", took place on 3 March 2020 in Brussels.

Relevant ART (Automated Road Transport) projects, such as CoEXist, ARCADE, TransAID, EU ITS Platform (EU EIP), INFRAMIX, STAPLE and DIRIZON, came together to share their results and lessons learnt, and participated in a fruitful discussion on the impacts and relevance of road infrastructure design and regulations, for CCAM deployment. FEHRL members and key stakeholders were invited to attend and engage in the discussion, thus considering the perspectives of different sectors.

The TransAID project seeks to liaise with thematically related research development and innovation (RDI) projects, especially in the Horizon 2020 thematic area of ART. Through this cooperation, it aims to enable the creation of synergies ensuring that all ART projects and initiatives can benefit from each other in order to enhance their innovation potential and harmonise their conclusions and products. TransAID will benefit from this knowledge and insights exchange, which contribute to the analysis and validation of its results and conclusions.

The workshops objectives were:

- Provide an overview of the research activities and results conducted by relevant ART projects (COEXIST, ARCADE, TransAID, EU ITS Platform - EU EIP, INFRAMIX, and STAPLE)
- Investigate the relation between CAVs and Infrastructure, and to discuss the complementarity of the conclusions from each project.
- Discuss with road infrastructure authorities and other stakeholders, the results from the project's implementation (impacts of CCAM on mobility in the studied use cases), and analyse the lessons/conclusions for cities in their mobility planning
- Steer cooperation among ART projects and key mobility stakeholders.

4.4.2 Workshop participants

The participants existed of members of the above-mentioned ART projects and there were several stakeholders present such as: national road authorities, European Commission and POLIS.

Figure 22: picture of the workshop participants

4.4.3 Report of the plenary session

The workshop existed of two plenary sessions. During the first session each of the ART projects provided an overview of their work. Afterwards, the second session consisted of a workshop discussing the relation between CAVs and (digital) infrastructure.

10:00 – 10:30	*Registration & Welcome coffee*
10:30 – 10:40	*Introduction* ***Thierry Goger**, FEHRL*
10:40 – 10:55	*CoEXist – overview of main results* ***Wolfgang Backhaus**, Rupprecht Consult GmbH*
10:55 – 11:10	*ARCADE – overview of main results* ***Stephane Dreher**, ERTICO*
11:10 – 11:25	*TransAID – overview of main results* ***Jaap Vreeswijk**, MAP Traffic Management*
11:25 – 11:40	*EU ITS Platform (EU EIP) – overview of main results* ***Maarten Amelink**, RWS*
11:40 – 11:55	*INFRAMIX – overview of main results* ***Martin Dirnwoeber**, AustriaTech*
11:55 – 12:10	*STAPLE – overview of main results* ***Adewole Adesiyun**, FEHRL*
12:10 – 12:25	*DIRIZON – overview of main results* ***Max Schreuder**, TNO*
12:25 – 12:30	*Q & A*
12:30 – 13:30	*Lunch break*
13:30 Workshop: Aligning structure and elements that we see as crucial with respect of infra support *Moderator: Thierry Goger, FEHRL*	
16:00	*End of the Meeting*

Figure 23: programme of the day

Links to each of the projects as well as the given presentations can be found here:
https://www.fehrl.org/news/joint-dissemination-of-h2020-cedr-projects-and-other-initiatives-related-to-cavs-and-infrastructure

Following the project presentations, Martin Russ (AustriaTech/INFRAMIX) and Thierry Goger (FEHRL) moderated the workshop, leading a joint discussion with all attendees.

The session initiated with a brief overview of the main results, conclusions and open questions identified in the morning's presentations. This included highlighting the available tools to simulate CCAM deployment scenarios and evaluate their potential impact on urban mobility, and the importance of further scenarios and cases to be tested.

In addition, the participants recognised the relevance of promoting knowledge exchange (making use of tools such as the European Commission's ITS Platform) and the need for enhanced cooperation between public and private stakeholders. Through collaboration with key actors, such as OEMs, road authorities, technical and research organisations, cities can steer efforts towards a common vision for CCAM deployment, in alignment with its policy goals.

For instance, CoEXist's results have showed how traffic performance can be negatively affected by the introduction of CAVs, during the initial transition period. It is up to cities to define, for which types of services and road categories, such results are desirable or to be avoided. Decisions about investments on physical and digital infrastructure, as well on the operational layer of urban mobility, can have a direct impact in the city's modal distribution.

In this way, beyond the state of technological development, the main challenge for cities is to define the CCAM services, the type of mobility system and solutions that they want to implement, and finding the right mix of infrastructure development, regulations and business models to achieve that vision.

The ISAD (Infrastructure classification Scheme for Automated Driving) developed by INFRAMIX (see section 1.4.2), presents a valuable input to further evaluate deployment scenarios, coupling the infrastructure type with the CCAM services implemented. This could deliver more concrete guidance for cities and National Road Authorities and Operators, with a general estimation of the required infrastructure investment to deploy each type of CCAM service, and what impacts can be expected.

Among the preparatory steps to enable effective action steering CCAM deployment, the development of an applicable legal and regulatory framework was recognised as a priority. To do so, cooperation at different governance levels should be encouraged.

Participants also discussed the issue of data usage and management. Following the approach described by TransAID, the need for a collaborative definition of quality criteria for the data was highlighted. Still, the question remains on which entity should perform the evaluation and on the definition of optimal C-ITS business models. An interesting example from Sweden was described, with an innovation cloud, clustering telecommunication organisations, service operators, road authorities and other key actors, to enable effective cooperation.

Considering the current high-level of uncertainty in the field, and how it restrains action from local authorities, participants recognised the need to identify 'no-regret' investments towards automation-readiness. An interesting possibility, is developing C-ITS capabilities which could generate benefits supporting vehicles with low level of automation, provide assistance towards safety improvements for instance, and serve for a more efficient traffic and network management. But, how to ensure compatibility and collaborative work towards an efficient and safe system? Who should develop the common data framework (e.g., map) which driving systems, information and management systems, and planning entities, all use?

After a day of interesting and constructive discussion, representatives from the different research projects and other attending stakeholders were able to evidence the value of knowledge exchange and cooperative effort. There is a great potential in the synergies that can be created among the products and lessons learnt from the various projects, to provide further guidance and knowledge to support decision-making and the optimal deployment of CCAM. In this sense, there was a common call for continued cooperation towards the harmonisation of research results, the identification of knowledge gap and opportunities for further development.

4.4.4 Implications to the TransAID work

The discussions confirmed the several challenges that TransAID encountered during the project. For each project, including TransAID, it is therefore important to stress that the results should be interpreted within the context of the assumptions, conditions and choices made in the project.

Given the broad scope of relevant aspects when deploying CCAM and the accompanying uncertainties, each project should focus their results and derived guidelines and/or roadmaps on the core of their research topic.

For TransAID this means the guidelines and roadmap need to focus on Transition Areas. What are they, where can we expect them, why and what is their impact (given the assumptions, conditions, and choices)? When TAs are identified, which services will help mitigate them and to what extent? In addition, it must be made clear what is needed to implement the services (processes, equipment, agreements, legal frameworks, etc.).

Furthermore, the identified need for collaboration and data sharing (e.g. disengagement reports) supports the concept of a future intermediary service to manage transition areas.

5 Summary

In line with T8.2, TransAID organised three stakeholder workshops and several surveys were held during other dissemination opportunities. In addition, three international ("twinning") expert meetings were organised to exchange views and findings with experts in Japan and the United States. Those meetings put some aspects of the "European" approach of TransAID and CCAM research in general into context of the developments in those areas. Furthermore, as reported in Chapter 4, several other events enabled interaction with other experts and stakeholders.

Observing the reports of all events, several recurring open issues, answers, and insights can be identified. Below, we give an overview of those. Note, however, that many relate to the introduction of automated driving in general. TransAID focusses on a very specific problem (managing mixed traffic in transition areas) and we found that little is known about that problem, which confirms the need and timeliness of TransAID.

The first stakeholder workshop was held at the beginning of the project and assisted by diverse representatives mostly coming from transport authorities or related R&D. The focus was on identifying relevant aspects to be considered for creation of use cases and scenarios at transition areas such as: the cause of disengagements, the transition of control process, expected levels of automated driving, relevant actors, etc. The short conclusion of that effort was that stakeholders and experts are still not able to provide answers with sufficient details. We did get better answers on the separate aspects, but those vary a lot depending on who you ask. This can be explained by the fact that automated driving is still very much in development, implementations can be very different depending on the considered scenarios (e.g. passenger cars on motorways vs. urban areas, shuttles or 'pods' with no or limited controls, open road or closed off environments, level of automation, etc.), and even for the same scenario distinct implementers may have alternative approaches.

Those differences and the uncertainties that come with them are reflected in how road authorities responded to our inquiries. City plans and policies in terms of automated vehicles will to some extent depend on the type of service that is offered by automation (e.g. private automated cars or automated shuttles). Road authorities are uncertain if they should focus on supporting private automated cars through digital infrastructure and/or should focus on complementing public transport with automated shuttles. Most road authorities have a vision of a greener future with less cars in the cities which is supported by current policies (e.g. reducing household/parking ratio, introducing environmental zones, stimulating car sharing and MaaS solutions). However, they are searching for the right steps to reach that future. Specifically, they are searching for information on how vehicle automation can support their transport and societal goals: when will automated driving be available and what will be its capabilities? Multiple events concluded with the fact that regions and cities (and politicians in general) need such information to be able to effectively steer their vision and proactively plan for the future.

Though much is still uncertain, there is recurring consensus regarding the need for connectivity to support automated driving and above to extend the ODD (see section 1.4.1) and enable cooperation between vehicles and infrastructure which leads to higher safety, efficiency, and comfort. Most experts foresee a hybrid solution with both ITS-G5 and cellular connectivity capabilities. Digitalisation of infrastructure by enabling digital messages (computing) from existing roadside equipment, increasing and improving road sensors and adding communication capabilities is seen as a 'no regret' step. To take the most advantage of TransAID services, it would require big efforts to digitalise road infra and dynamic (traffic management) schemes. Due to the effort, the services might not be feasible in the short term in urban scenarios. Therefore, it makes sense to start on motorways and then consider applicability to urban roads. *Note: TransAID primarily focusses on urban scenarios.*

To some extent there is also consensus for the need of sharing data on vehicle capabilities on the one hand and infrastructure (support) capabilities on the other. During the TransAID project, the concept of Operational Design Domain (ODD) was encountered with increasing frequency. The 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 (weather, daytime/night time, etc.), prevailing traffic law and regulations, and other domain constraints.

Transport Authorities expressed high interest in getting insights into the ODD restrictions of the OEMs and to define criteria for ODDs. The aim is to be in the position of allowing vehicles of different automation capabilities to use specific roads and to be able to control the use or number of automated vehicles in certain areas.

On the other hand, OEMs indicated that a definition of an ODD is very complex to achieve and can depend on a lot of parameters, especially those influencing the vehicle's sensing side. Several such parameters may be defined, including sensor capabilities but also environmental aspects like direction of light, glare, reflection of materials, fog conditions, etc. Therefore, it was deemed to be impossible to have a common definition which would be valid for all vehicles and independent of their sensor setup. It was agreed that focusing on resulting driving capabilities instead of sensor capabilities would be helpful.

In short, within the field of automated driving there is an ongoing search for a framework through which the ODD can be defined. Note that such developments have recently started, e.g., the definition of ODD taxonomies in ISO 34503 or BSI PAS 1883, or the definition of open formats like OpenODD[18]. In addition, if the ODD concept becomes successful it is not only important during the introduction of automated vehicles. It was also recognised that, for the foreseeable future, automated vehicles will always have limitations, despite expected advancements in the field. Therefore, the ODD remains important, also in the more distant future, to determine where the limits of automated driving are and to match the ODD to the infrastructure capabilities (see next paragraph).

At the same time, INFRAMIX has introduced the Infrastructure Support Levels for Automated Driving (ISAD) concept (see section 1.4.2). ISAD levels define road infrastructure characteristics and capabilities in support of automated vehicles. The ISAD concept is recognised as an important tool in the cooperation between different ITS stakeholders (primarily road authorities and OEMs). However, just like the ODD concept, ISAD is still under development and, for example, the aspect of HD maps is currently underexposed. It can be assumed that ISAD levels can be one of the parameters considered for ODD definitions. Consequently, by matching ISAD levels to the ODDs, one could, theoretically, identify mismatches which point to transition areas.

The need of sharing data between road authorities and OEMs for a correct and usable characterization of ODD and ISAD concepts was primarily supported by road authorities and researchers. Contrary, OEMs were identified to be more hesitant to share such information because of competition, possible liability issues, and because they (rightfully) foresee big challenges to define the ODD.

Because of the sensitivity of the information being shared, at least from the OEM perspective, TransAID had introduced the intermediary service concept. This service could act as a trusted (third) party to collect OEM information and publish aggregated and anonymised data which is

[18] https://code.asam.net/simulation/proposal/openodd

needed for road authorities (i.e. city planning, traffic measures, etc.) and/or researchers. This concept (using standardised open definitions / reports) was generally supported, but somewhat hesitantly because of doubts whether it will work in practice and whether it would be accepted by OEMs. Nevertheless, the same service would also facilitate the consolidation of ODD and ISAD knowledge and could act as a single point of access (or a few of them) for both road authorities and OEMs. That could facilitate the cooperation between them (see TransAID D4.3 for more information).

When talking about matching ODD to ISAD the topic of liability almost always comes up. For example, imagine a road being classified as able to reliably provide all the information that a given OEM would need to let his automated cars drive safely at SAE level 4 under a specific ODD. When some infrastructure component breaks down and consequently there is an accident, who is responsible? The driver, vehicle manufacturer, road operator or roadside equipment manufacturer? This is not an easy question and the need of new governing/regulatory framework is recognised with no exception. It is also recognised that cross-country differences further complicate such frameworks because of differences in the legal landscape. Something that was also observed when TransAID visited the US for a twinning event with the U.S. CAMP. Financial consequences because of liability (through lawsuits) can be quite substantial, which is one of the reasons U.S. OEMs are very hesitant when considering V2X infrastructure support for automated driving.

On the other hand, during events in Europe and Japan the infrastructure support (and hence communications) is welcomed by the majority of stakeholders. Additionally, it was often acknowledged that there is the need to adapt traffic rules for automation, for example, to differentiate speed/relevance areas for different categories of vehicles. In addition, infrastructure must be authorized by road authorities to provide advices to vehicles (that possibly break traffic rules) in a fast and dynamic way or be mandated for recurrent situations. This was an important finding and points again to the need of new regulation.

Stakeholders were also asked specifically what they thought of the five TransAID services which were created and studied. In general, the services are positively received, except for traffic separation (i.e. service 3: separating automated vehicles from non-automated vehicles by assigning different lanes). Our own studies confirm that the needed space upstream of a transition area, the needed ITS-G5 coverage and degree of coordination needed, make it hard to utilise the potential of that service. During multiple events, service 2 "provide speed, headway and/or lane advice" was pointed out as the most promising service.[19]

Though traffic separation as a mitigating measure was dismissed, it was indicated dedicated lanes for automated vehicles could be considered as an incentive for automated driving to reach long term goals of safety/efficiency. However, due to possible reduced capacity (blocking a lane for remaining traffic), it is best to use dynamic assignment which considers the traffic composition. At the beginning and end of dedicated lanes there is a likelihood for a transition area which could need some form of support measures as introduced by TransAID. In addition to dedicated lanes, a large group foresees areas where automated driving should not be allowed. This directly confirms another possible reason for future transition areas.

In addition to the TransAID services, remote operation is an emerging possible solution at least for management of level 4 automated public transport (e.g. autonomous shuttles or pods) in edge cases and transition areas, when the vehicles operate without a steward in the vehicle. It would be

[19] Service 3 was dropped after the first project iteration and freed resources were used to study a second service 2 use case during the second project iteration.

interesting to investigates its effectiveness with similar evaluations means as those utilized by TransAID.

Feedback was not only sought on the usefulness of the services, but also the implementation of them through our simulations. For a correct validation of services, it is important that the vehicle models (i.e. the behaviour of (non-)automated vehicles) are accurate. Regarding lane change modelling, it was recognized that lane change behaviour of automated vehicles is expected to be more conservative (in terms of safe gaps) compared to manually driven vehicles. However, this implies increased heterogeneity in mixed traffic conditions (legacy – automated – connected and automated vehicles). To avoid this effect, it was suggested that automated vehicles could be developed to adopt more human-like approaches in terms of lane changing, but this would be a big challenge.

With respect to modelling/simulating transitions of control procedures, it was confirmed that drivers should be allowed to take-over vehicle control during such and minimum risk manoeuvres. Also it was confirmed that in such situations vehicles should always be guided to a safety harbour (e.g. side-street location) to prevent safety-critical situations on the mainline lanes (e.g. rear-end collisions due to stop in lane).

In conclusion, from an innovation standpoint these are exciting times for aspects regarding automated driving and its relation with road infrastructure and traffic management. As we have experienced, the uncertainties will not disappear soon or new uncertainties will arise. According to what is explained in this deliverable, stakeholder consultation did not provide all the insights desired by TransAID. Also, it is fair to say that vehicle manufacturers or suppliers were often absent or underrepresented in stakeholder consultation events and conferences. TransAID tried to overcome that by organising dedicated meetings with OEMs (e.g. several dissemination activities in EU with the C2C-CC, or a dedicated workshop with the US CAMP), but usually feedback was very limited because of the sensitivity of the information from the OEMs perspective with respect to competitors (i.e. company policies, NDAs, intellectual property, etc.).

Nevertheless, what can be observed from the sequence of stakeholder consultation events is that there is steady progression in the collective understanding of the relation between vehicle automation and infrastructure and the possible implications to the stakeholders involved. By now it seems that there is a common interest, even by vehicle manufacturers, to develop a comprehensive standard and/or taxonomy for classifying operational design domains of automated vehicle systems and infrastructure support levels of automated driving. Yet, these efforts are still at an early stage.

6 References

1. Pribyl, O. et al. (2017), Deliverable 2.1: User needs, conceptual design and requirements, MAVEN, Managing Automated Vehicles Enhances Network.

2. Wijbenga, A. et al. (2018), D2.1 Use cases and safety and efficiency metrics, TransAID project deliverable, URL: https://www.TransAID.eu/deliverables/

3. Wijbenga, A. et al. (2019), D2.2 Scenario definitions and modelling requirements, TransAID project deliverable, URL: https://www.TransAID.eu/deliverables/

4. Maerivoet, S. et al. (2018), D4.1 Overview of Existing and Enhanced Traffic Management Procedures, URL: https://www.TransAID.eu/deliverables/

5. Lu, M. et al. (2020), D9.5 TransAID Final Conference Programme, TransAID project deliverable, URL: https://www.TransAID.eu/deliverables/

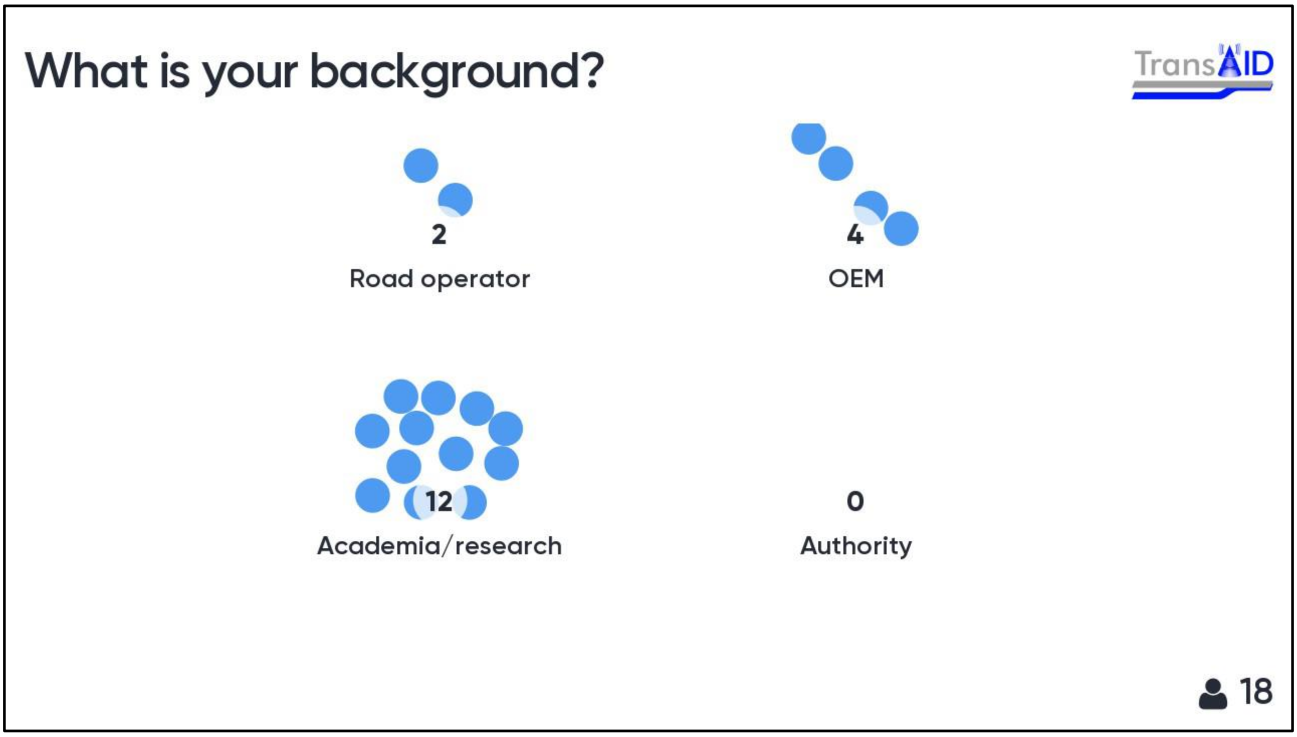
6. Manganiaris, S. et al. (2019), D5.4 Infrastructure Classification Scheme, INFRAMIX project deliverable, URL: https://www.inframix.eu/wp-content/uploads/D5.4-Infrastructure-Classification-Scheme.pdf

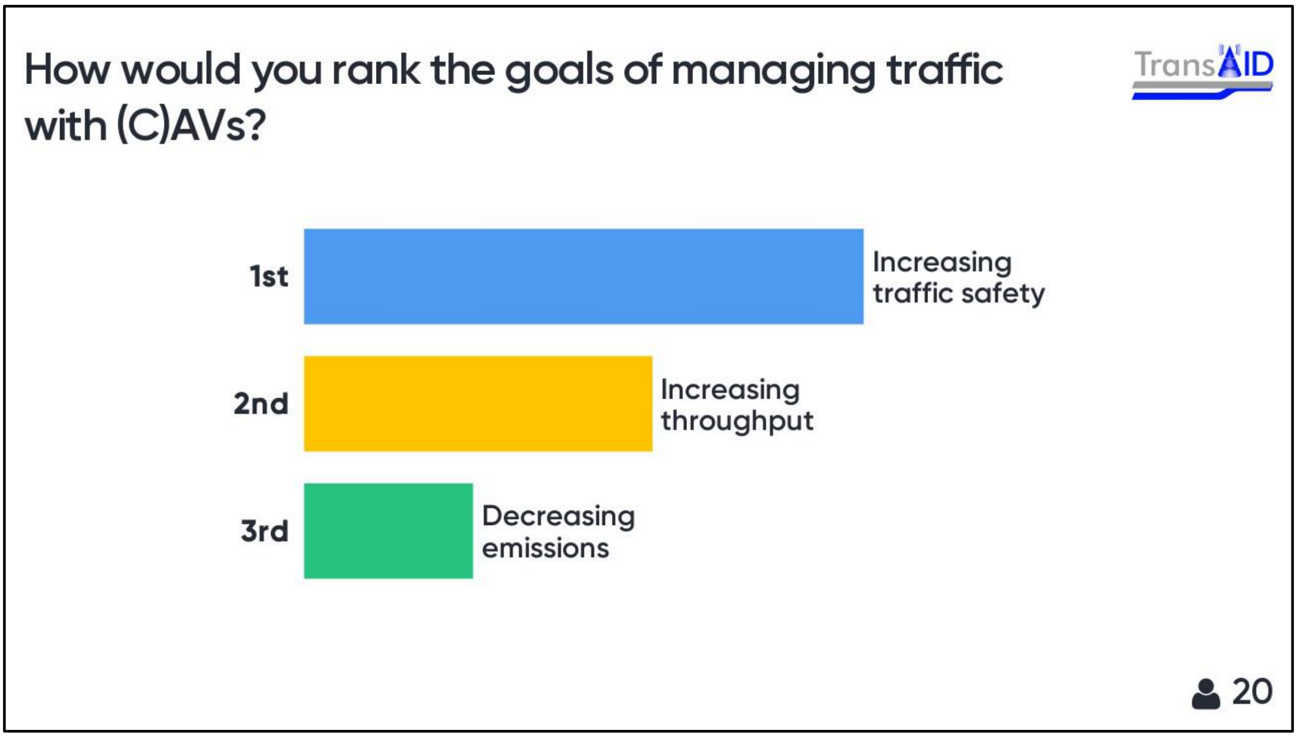
7. Amditis, A. et al. (2019), Road Infrastructure taxonomy for connected and automated driving. In: Cooperative Intelligent Transport Systems, Towards high-level automated driving, IET, Chapter 14. p. 309-325.

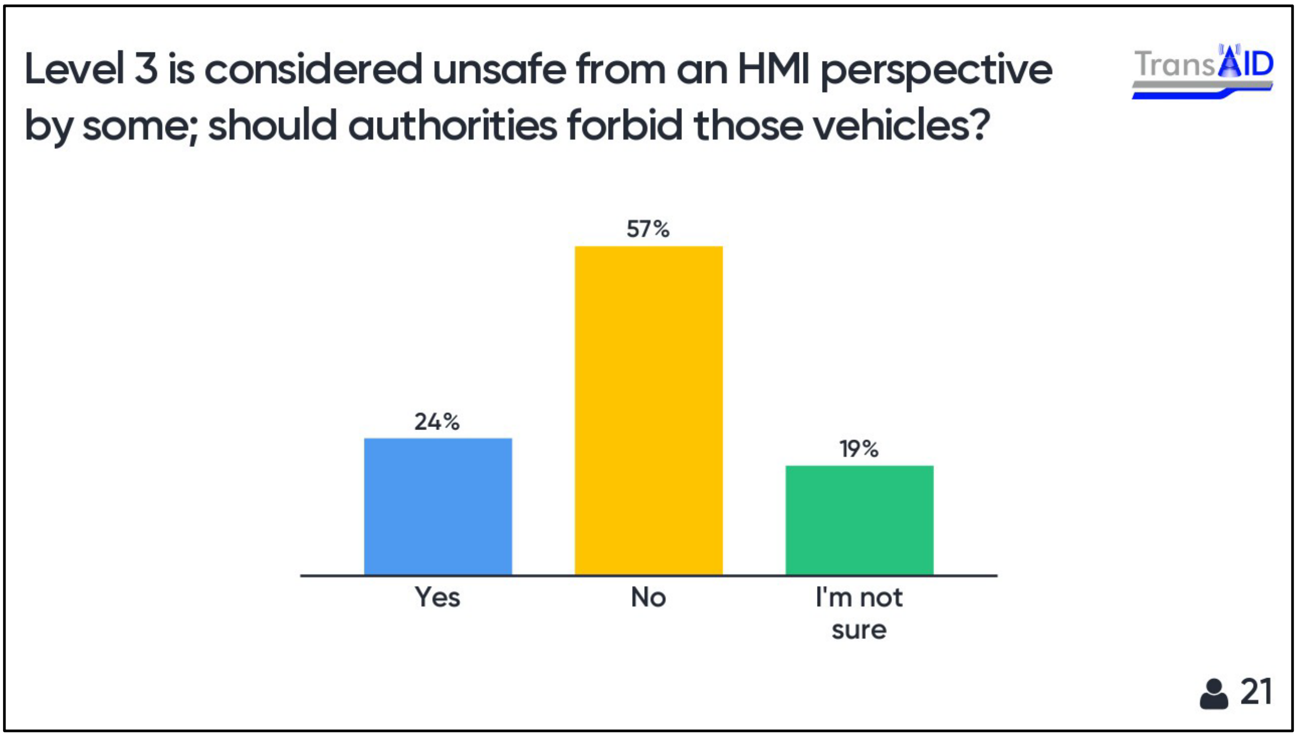
8. European Research and Innovation Programme Horizon 2020 INFRAMIX project, Infrastructure Categorization, URL: https://inframix.eu/infrastructure-categorization/

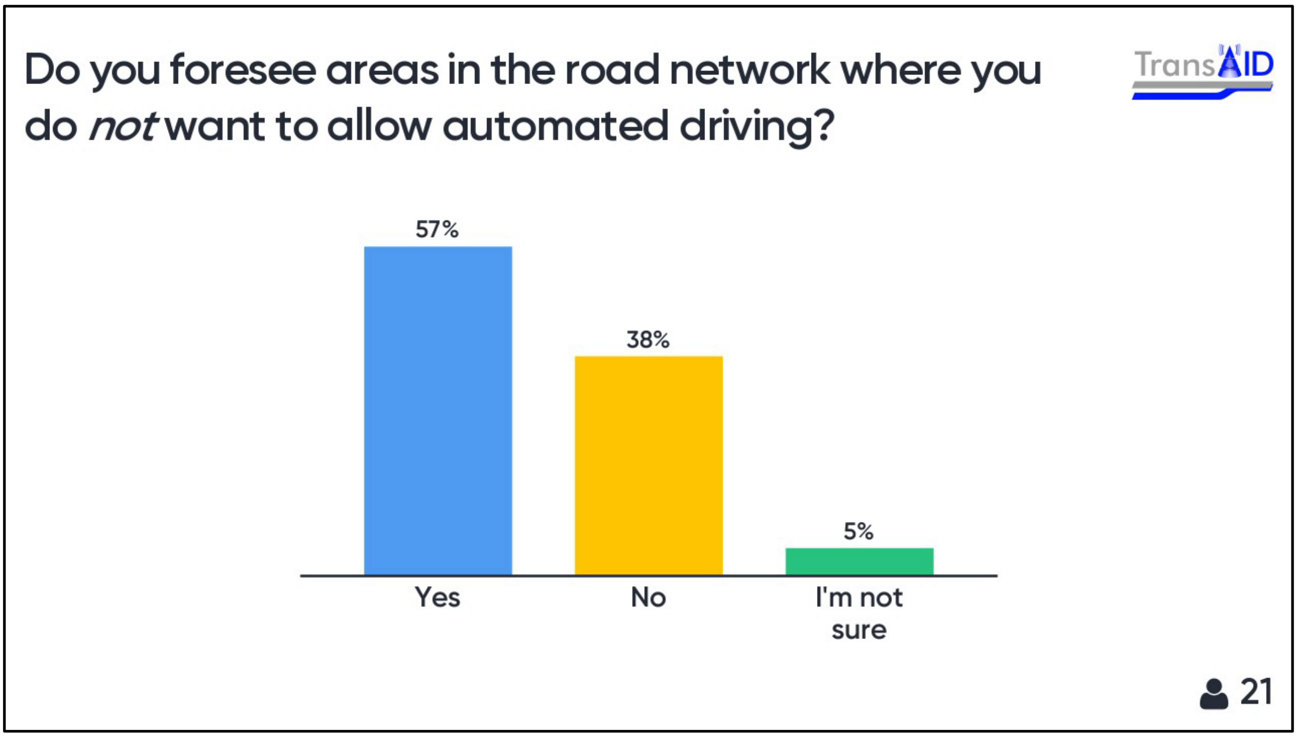
Appendix A: Detailed survey results TransAID session at the IEEE-IV conference (Paris)

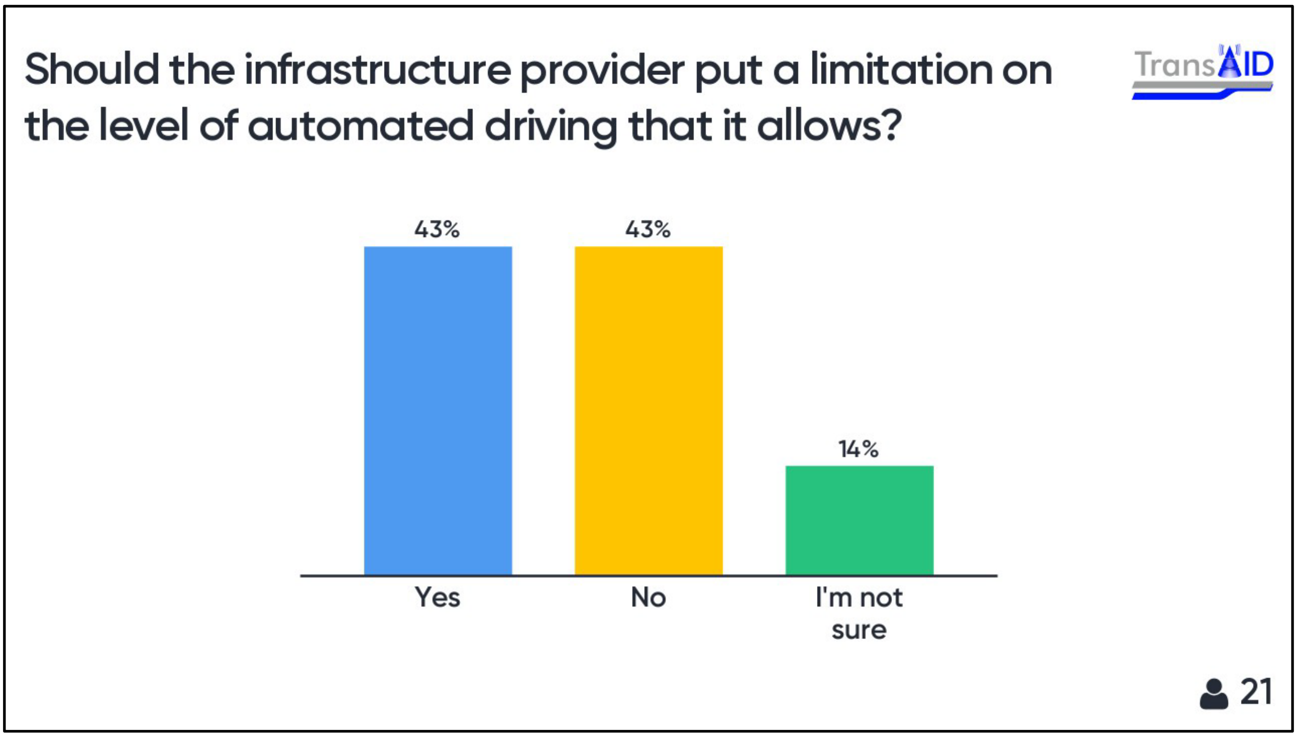
A.1 First session results

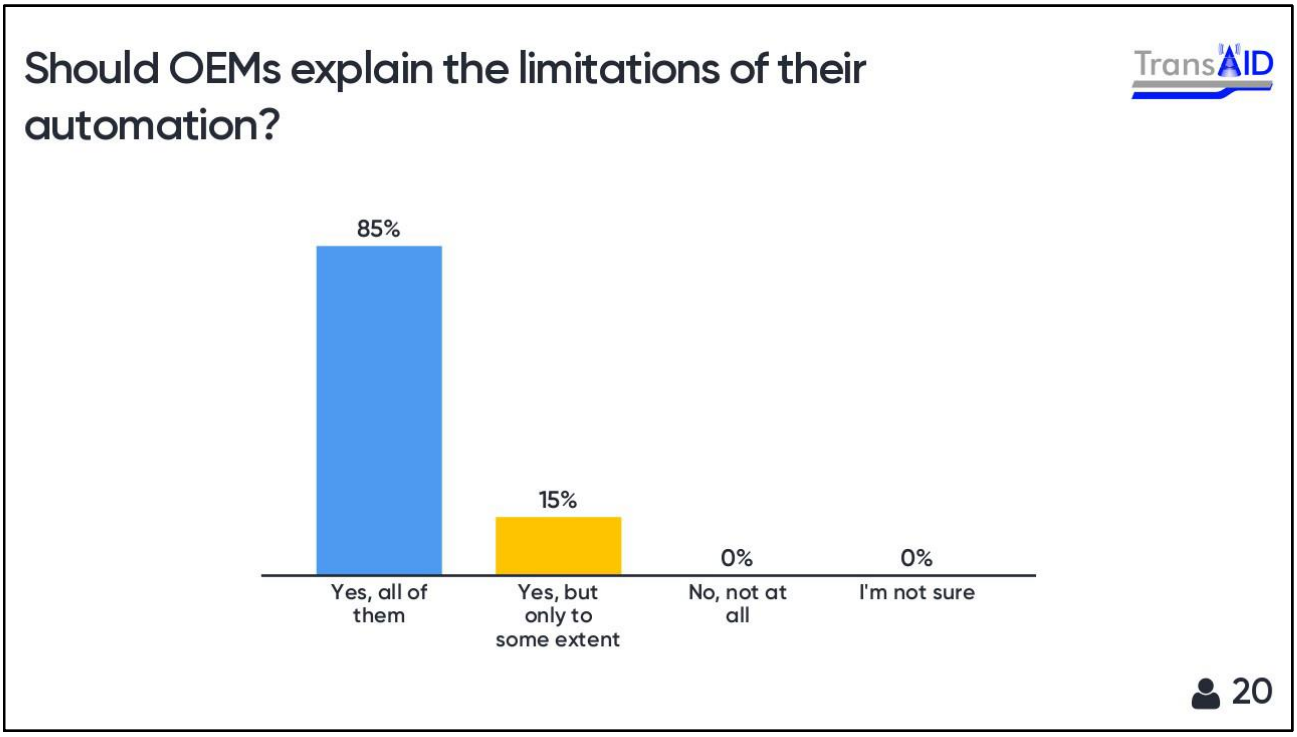


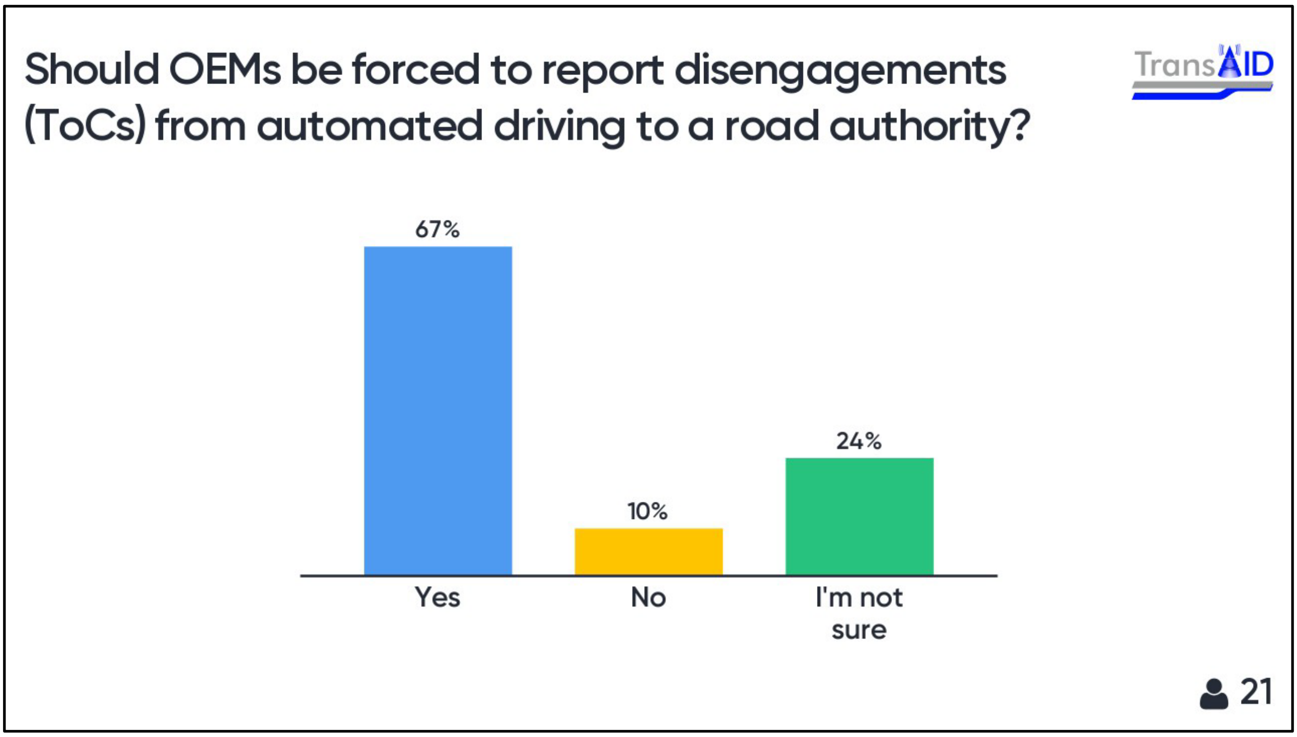

How would you rank the goals of managing traffic with (C)AVs?
1st
Increasing traffic safety
2nd
Increasing throughput
3rd
Decreasing emissions
20

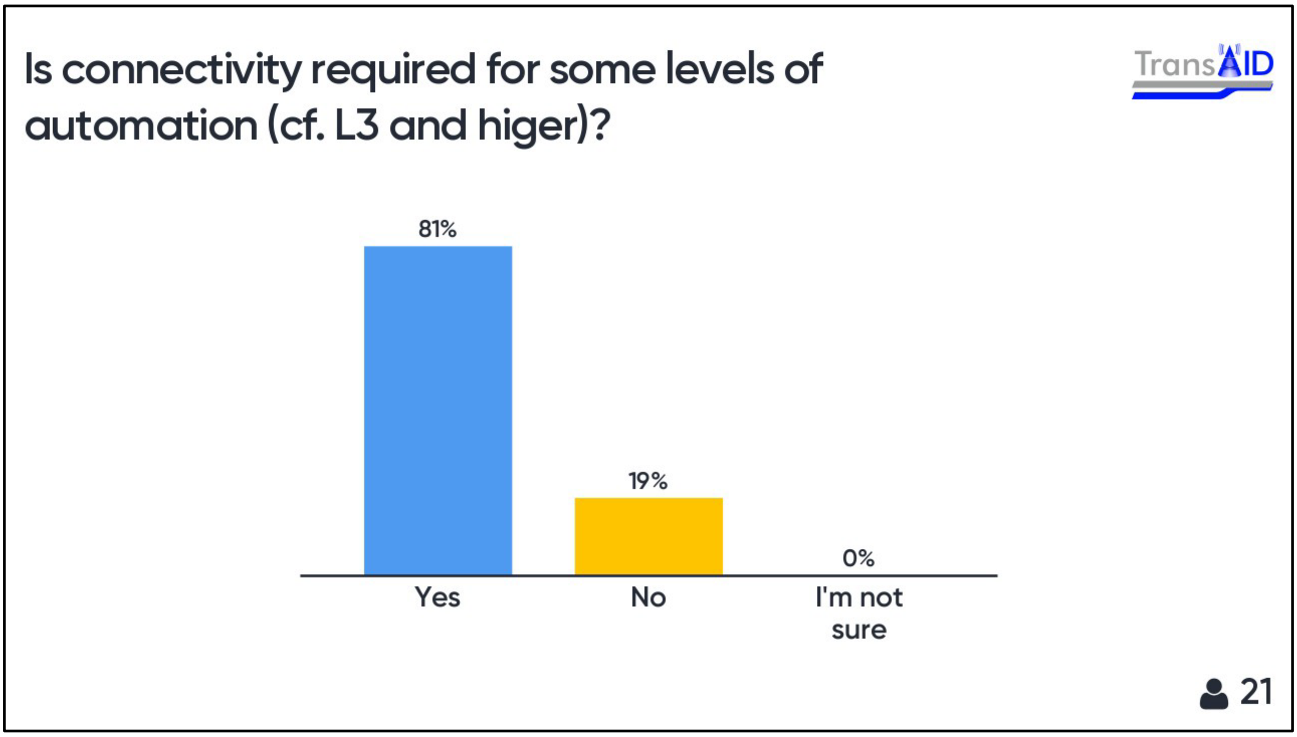

Level 3 is considered unsafe from an HMI perspective by some; should authorities forbid those vehicles?
24%
57%
19%
Yes
No
I'm not sure
21

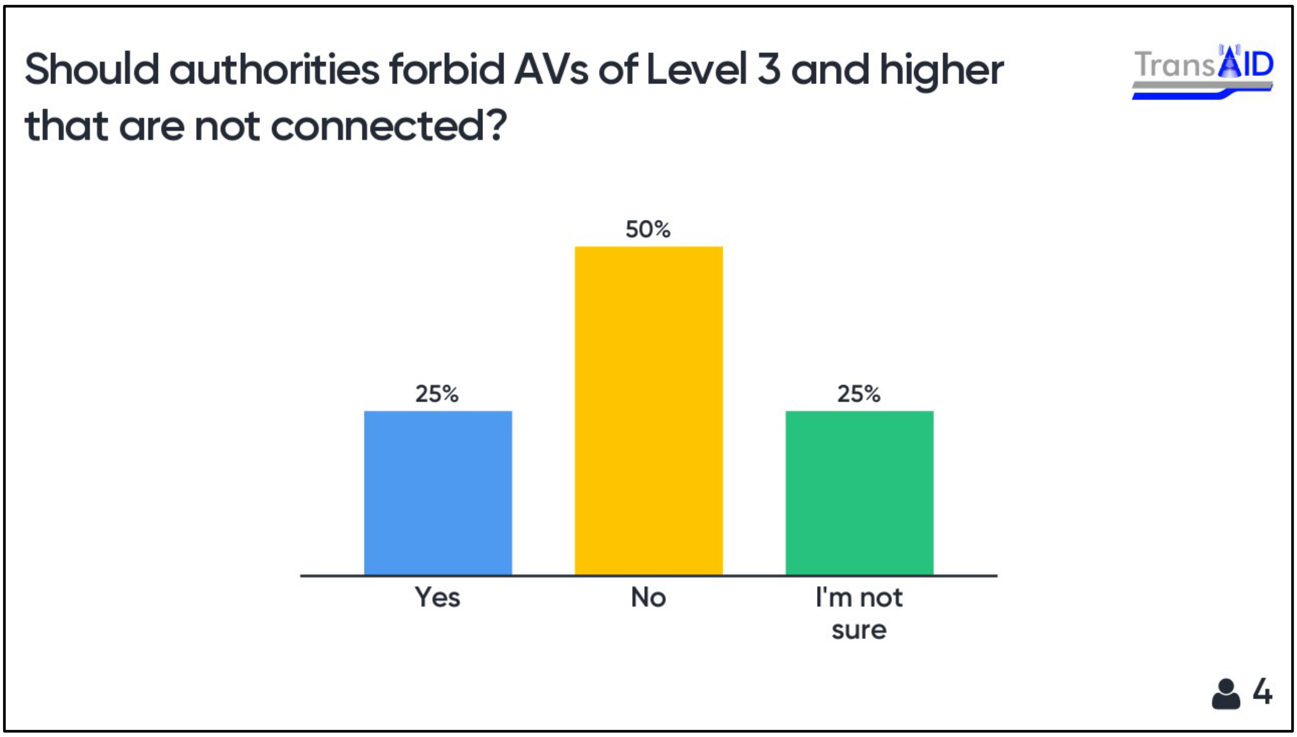

Do you foresee areas in the road network where you do *not* want to allow automated driving?
TransAID
57%
38%
5%
Yes
No
I'm not sure
21


Should the infrastructure provider put a limitation on the level of automated driving that it allows?
TransAID
43%
43%
14%
Yes
No
I'm not sure
21

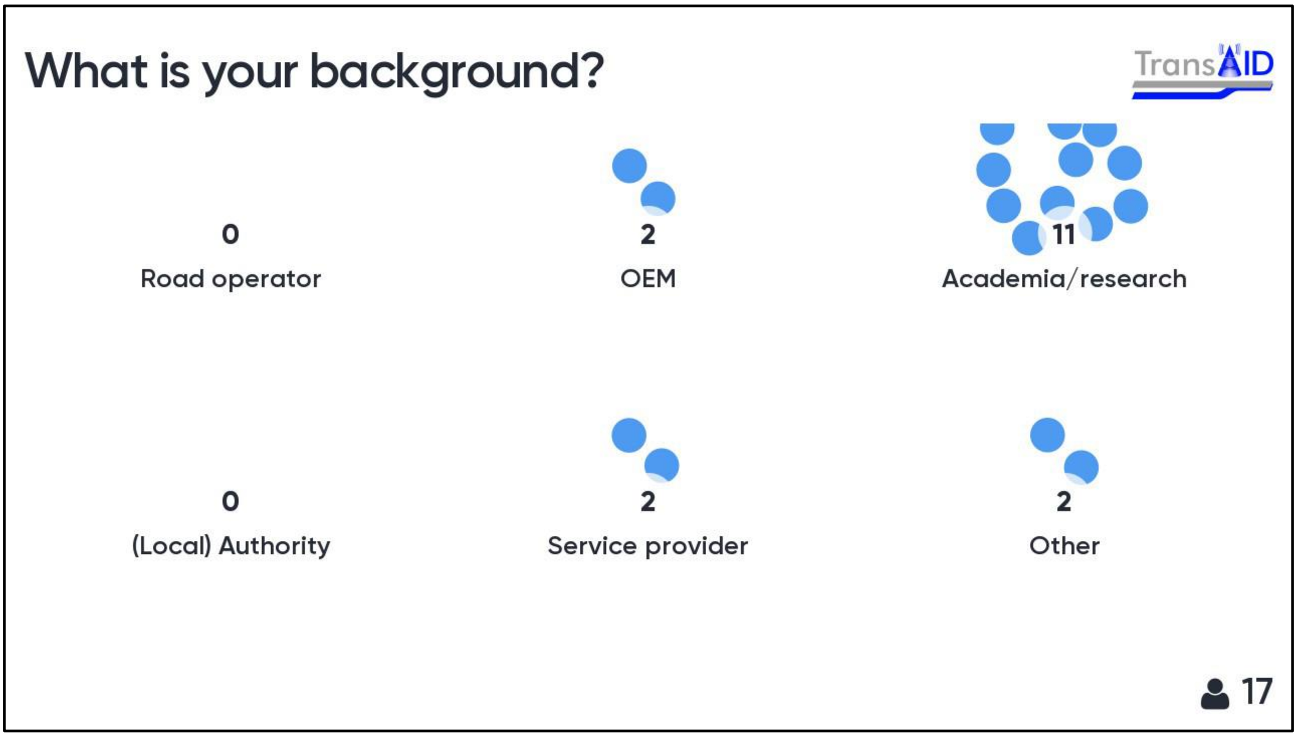

Should OEMs explain the limitations of their automation?
TransAID
85%
15%
0%
0%
Yes, all of them
Yes, but only to some extent
No, not at all
I'm not sure
20

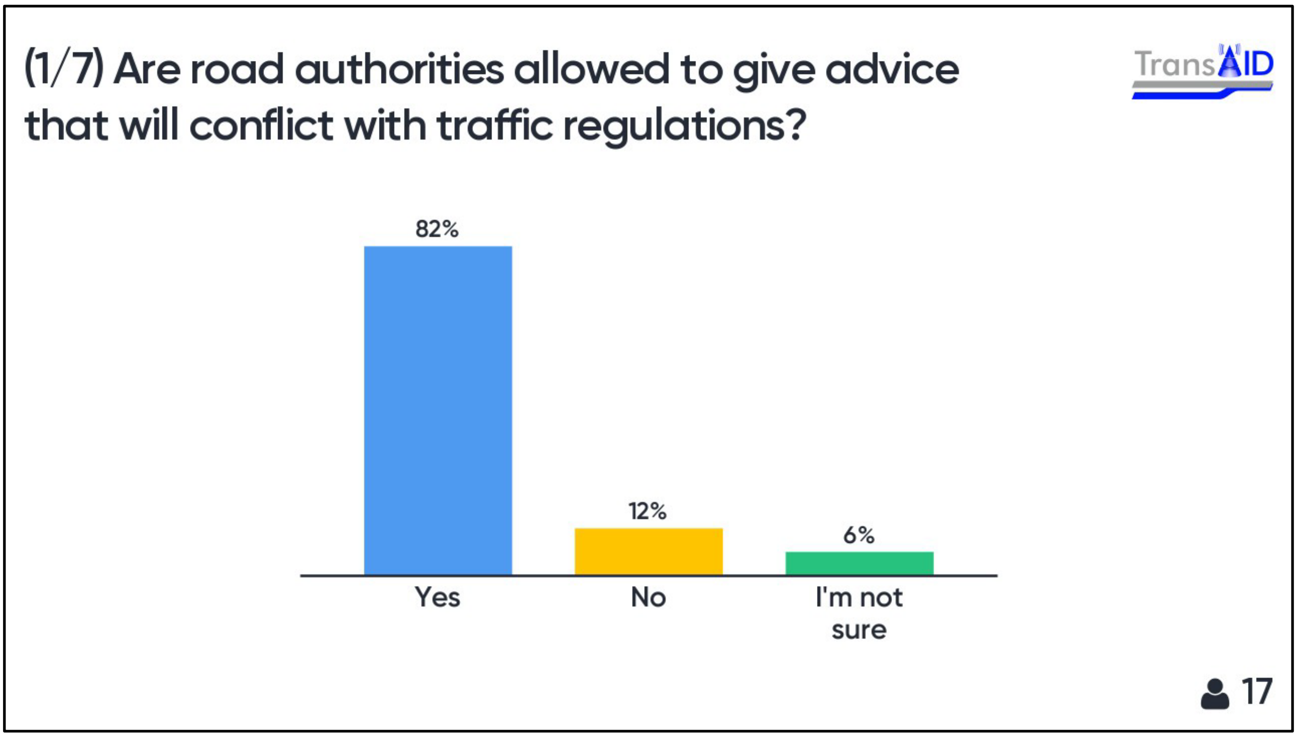

Should OEMs be forced to report disengagements (ToCs) from automated driving to a road authority?
TransAID
67%
10%
24%
Yes
No
I'm not sure
21

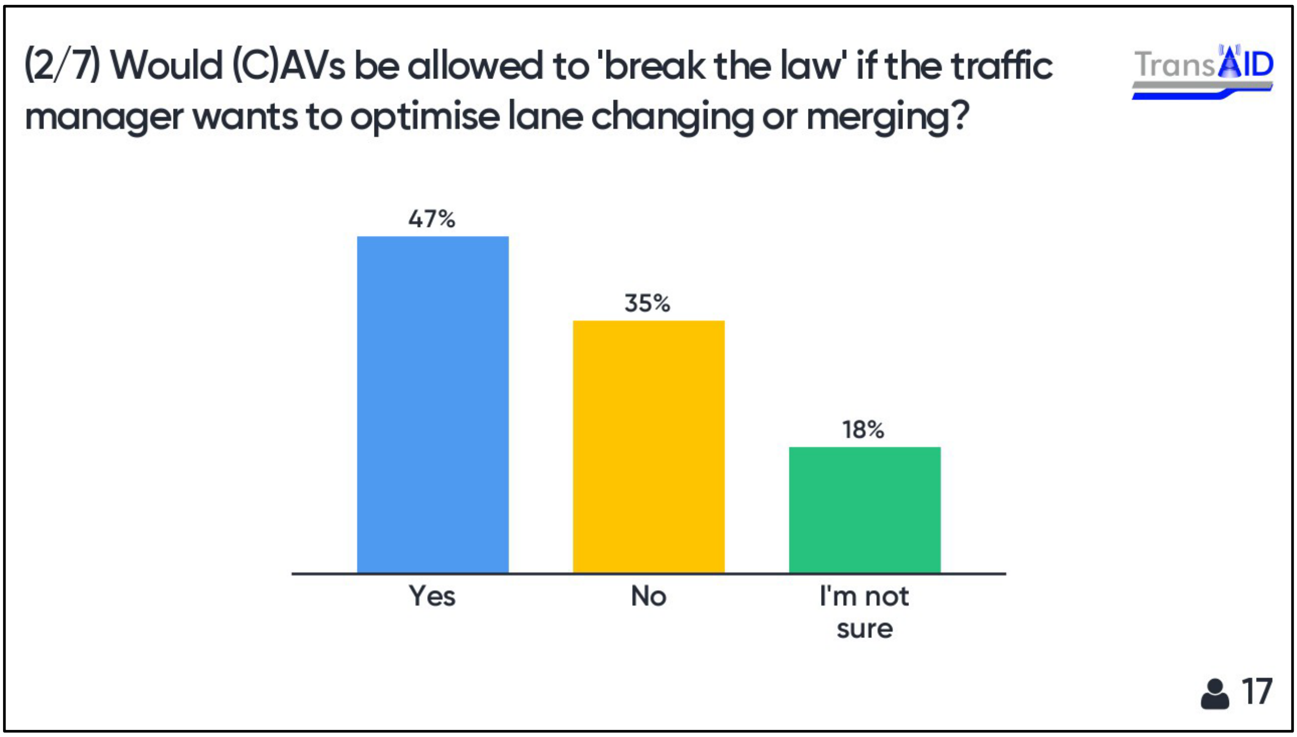

Is connectivity required for some levels of automation (cf. L3 and higer)?
TransAID
81%
19%
0%
Yes
No
I'm not sure
21

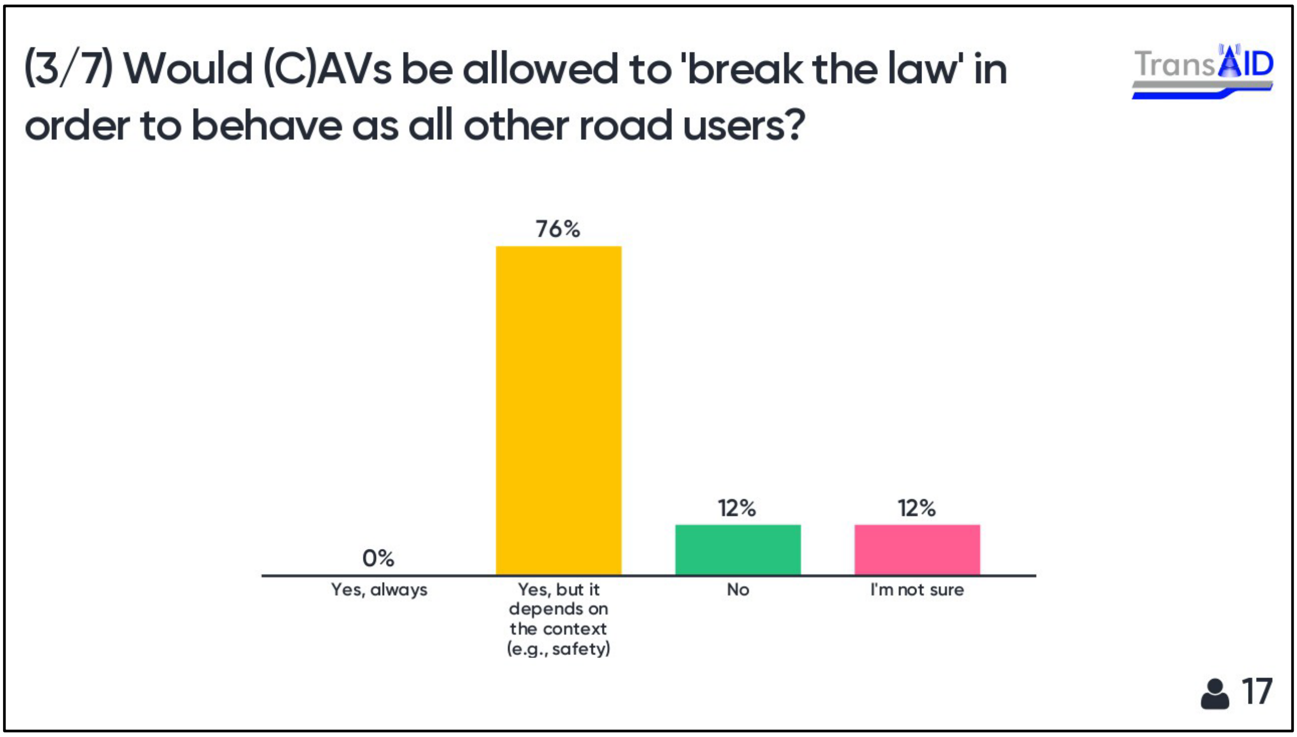

Should authorities forbid AVs of Level 3 and higher that are not connected?
TransAID
50%
25%
25%
Yes
No
I'm not sure
4

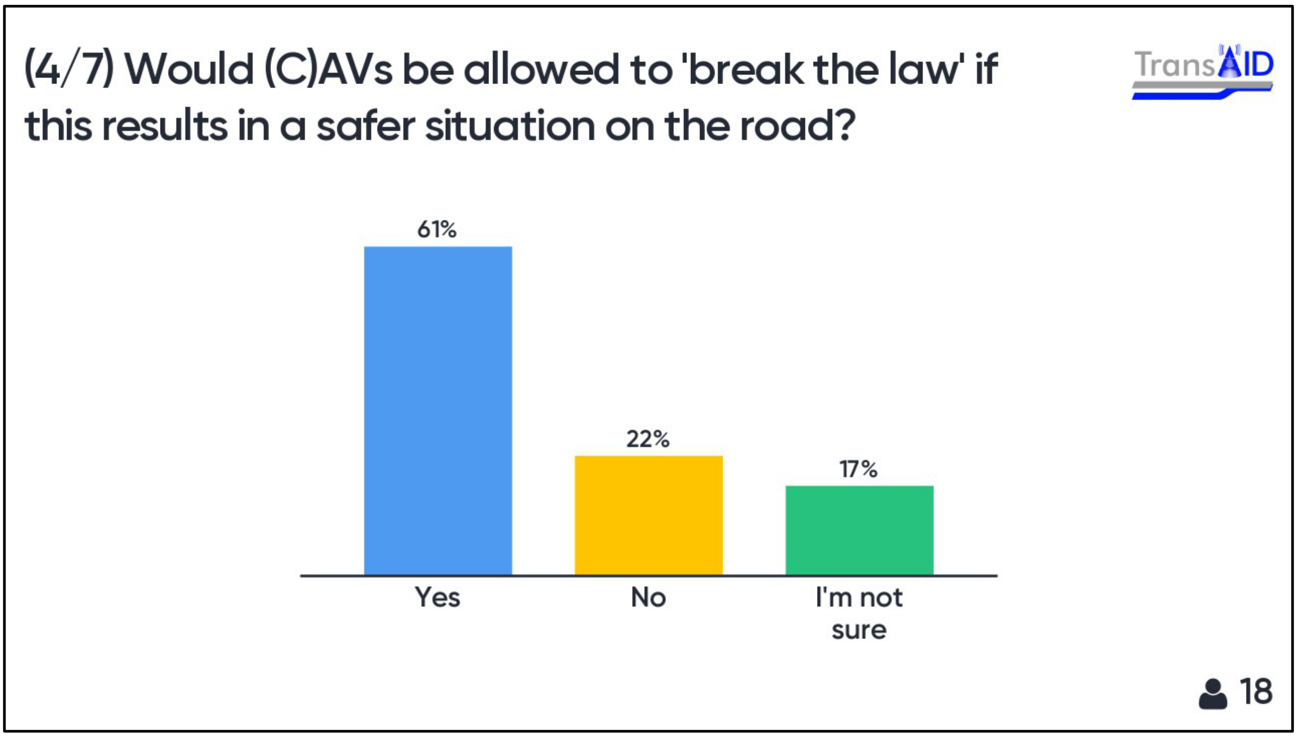
A.2 Second session results

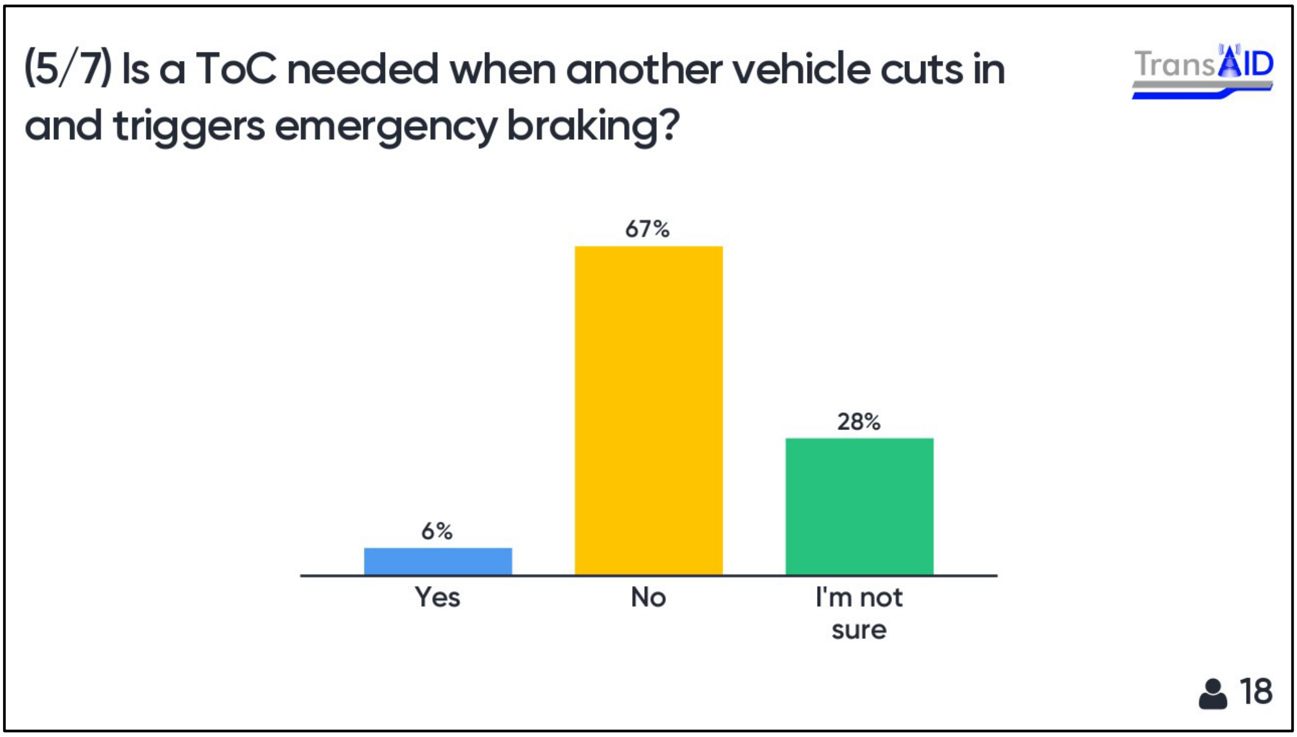


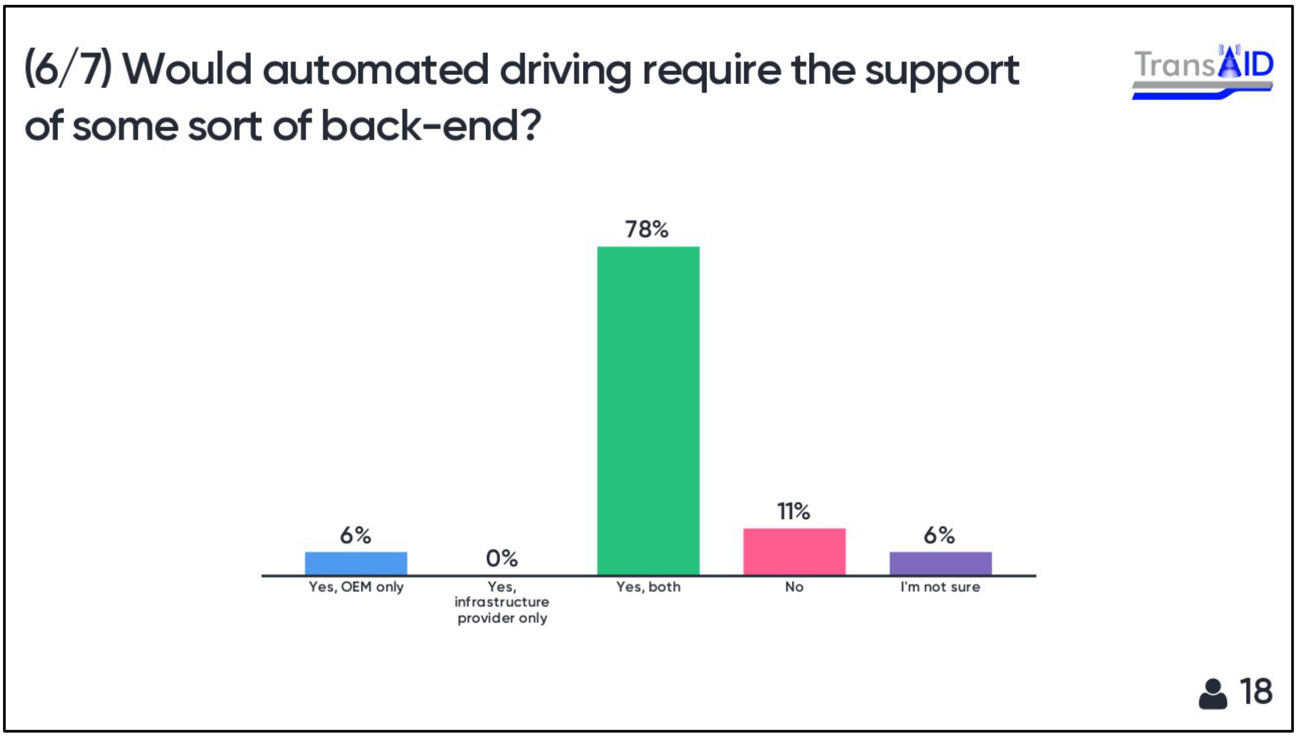



(2/7) Would (C)AVs be allowed to 'break the law' if the traffic manager wants to optimise lane changing or merging?
TransAID
47%
35%
18%
Yes
No
I'm not sure
17


(3/7) Would (C)AVs be allowed to 'break the law' in order to behave as all other road users?
TransAID
0%
76%
12%
12%
Yes, always
Yes, but it depends on the context (e.g., safety)
No
I'm not sure
17

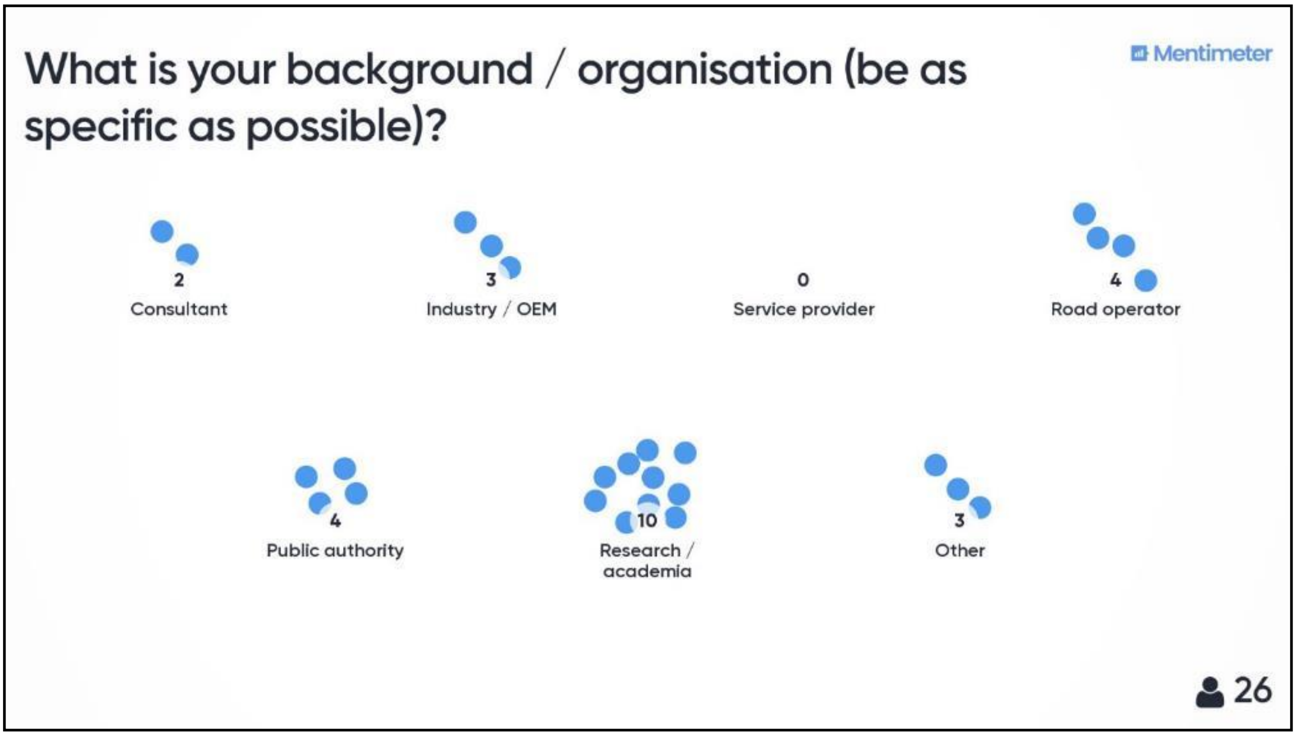

(4/7) Would (C)AVs be allowed to 'break the law' if this results in a safer situation on the road?
TransAID
61%
22%
17%
Yes
No
I'm not sure
18

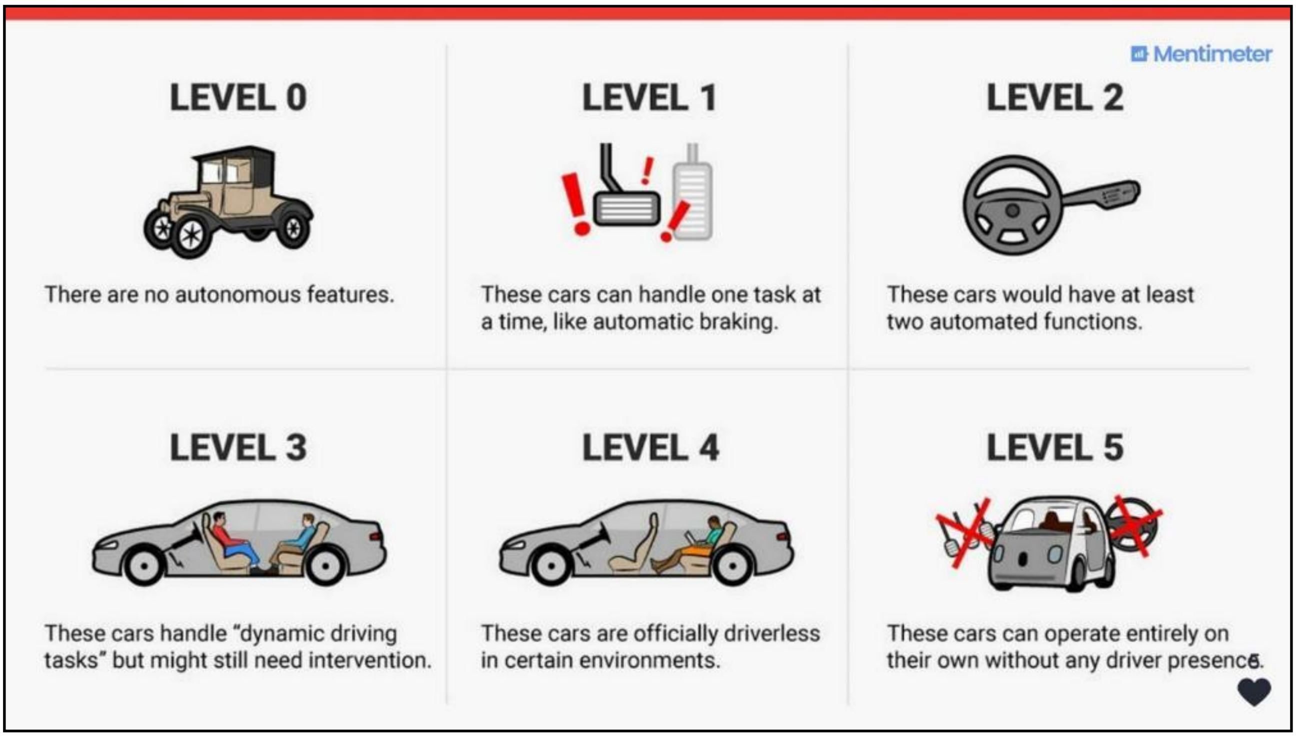

(5/7) Is a ToC needed when another vehicle cuts in and triggers emergency braking?
TransAID
67%
28%
6%
Yes
No
I'm not sure
18

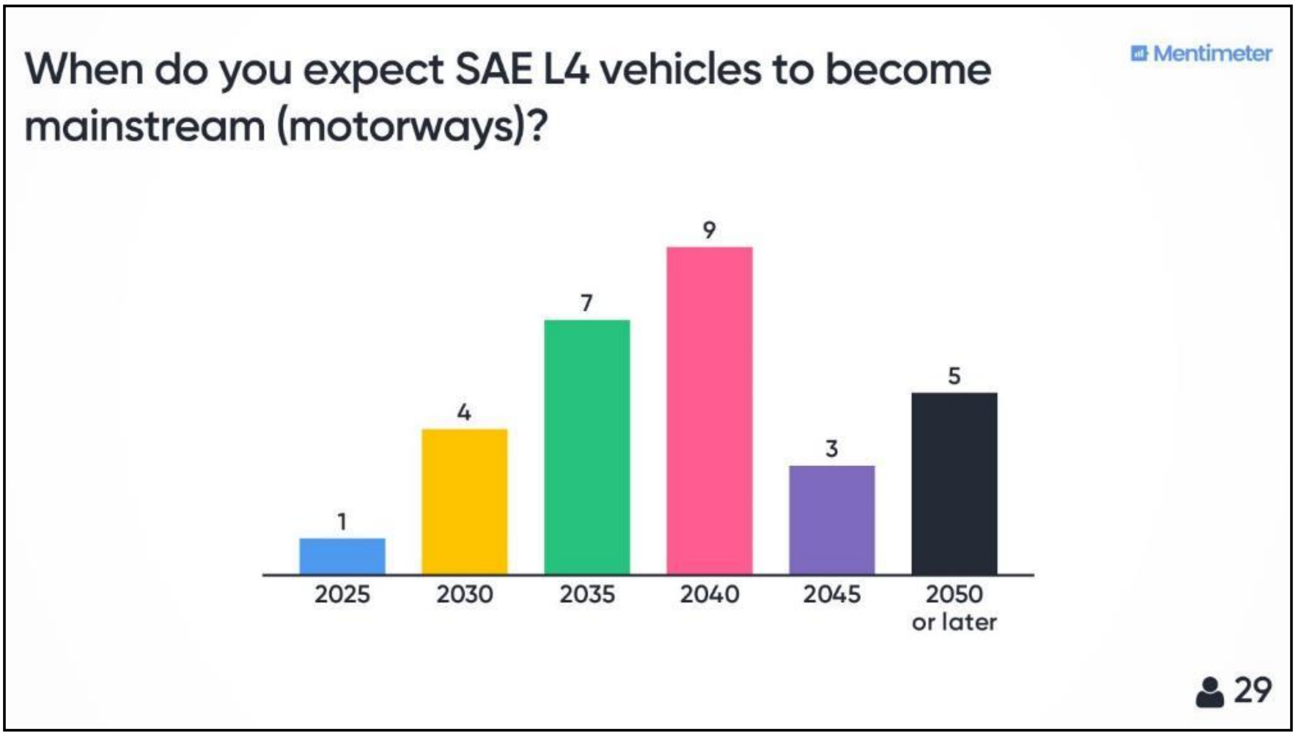

(6/7) Would automated driving require the support of some sort of back-end?
TransAID
78%
6%
0%
11%
6%
Yes, OEM only
Yes, infrastructure provider only
Yes, both
No
I'm not sure
18

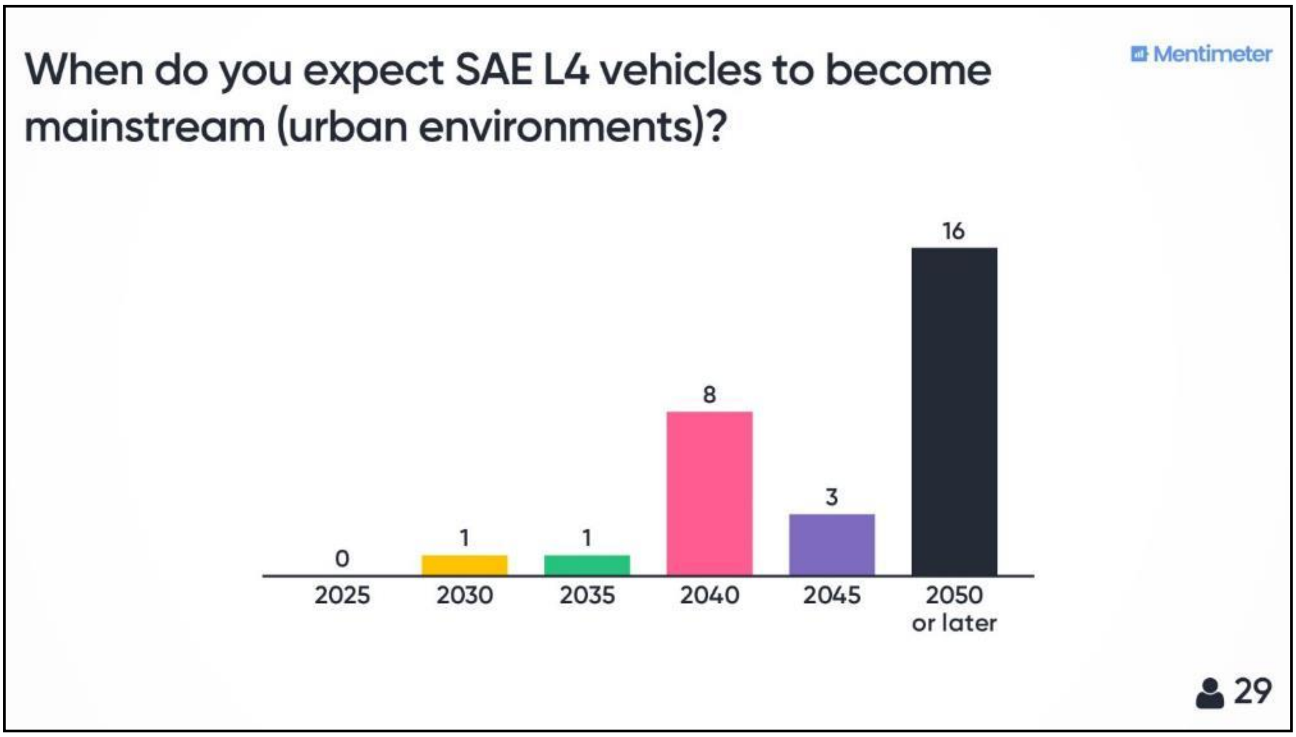
Appendix B: Detailed survey results TransAID-INFRAMIX stakeholder workshop

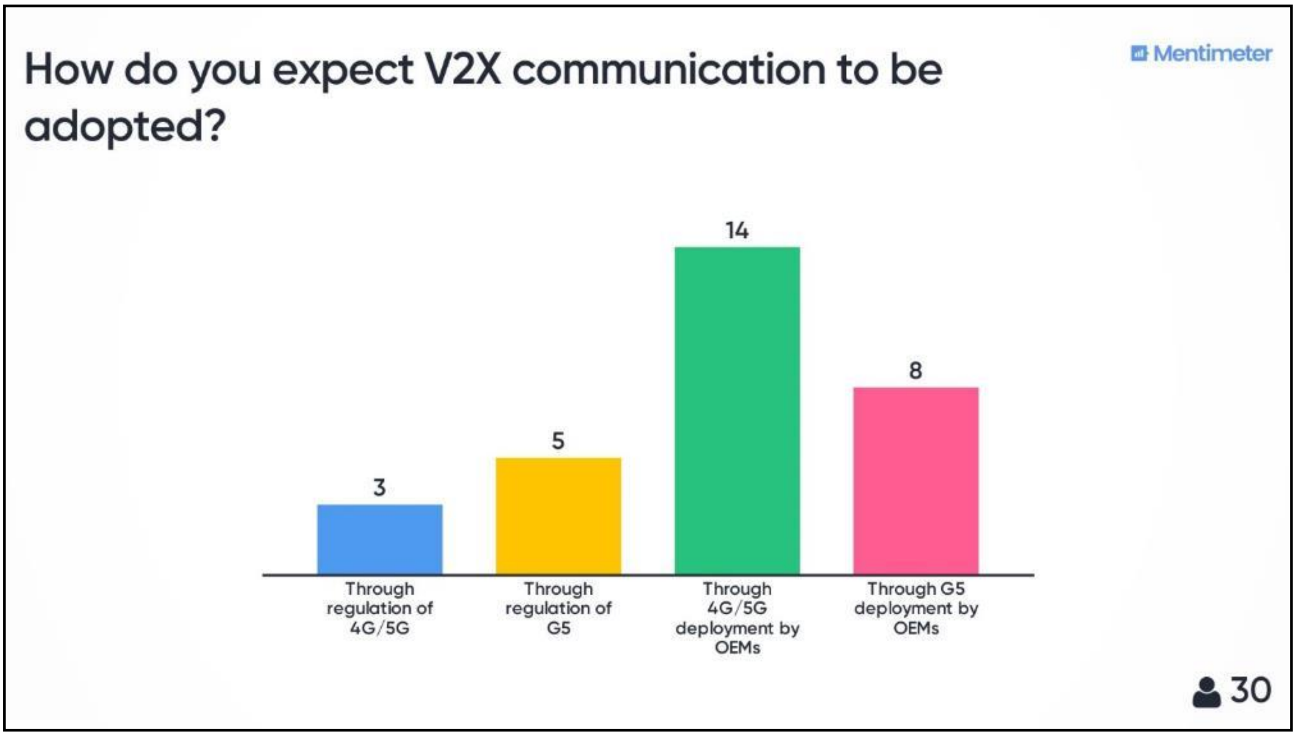
B.1 First session results

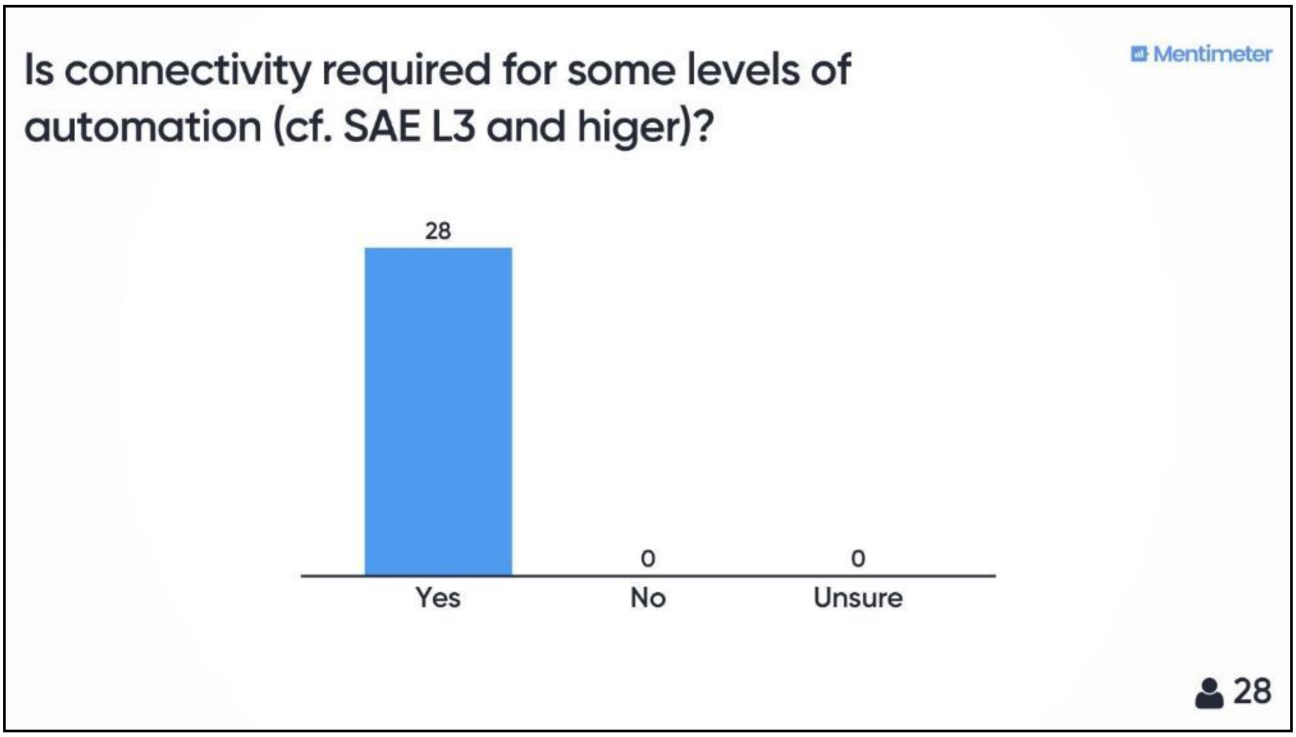


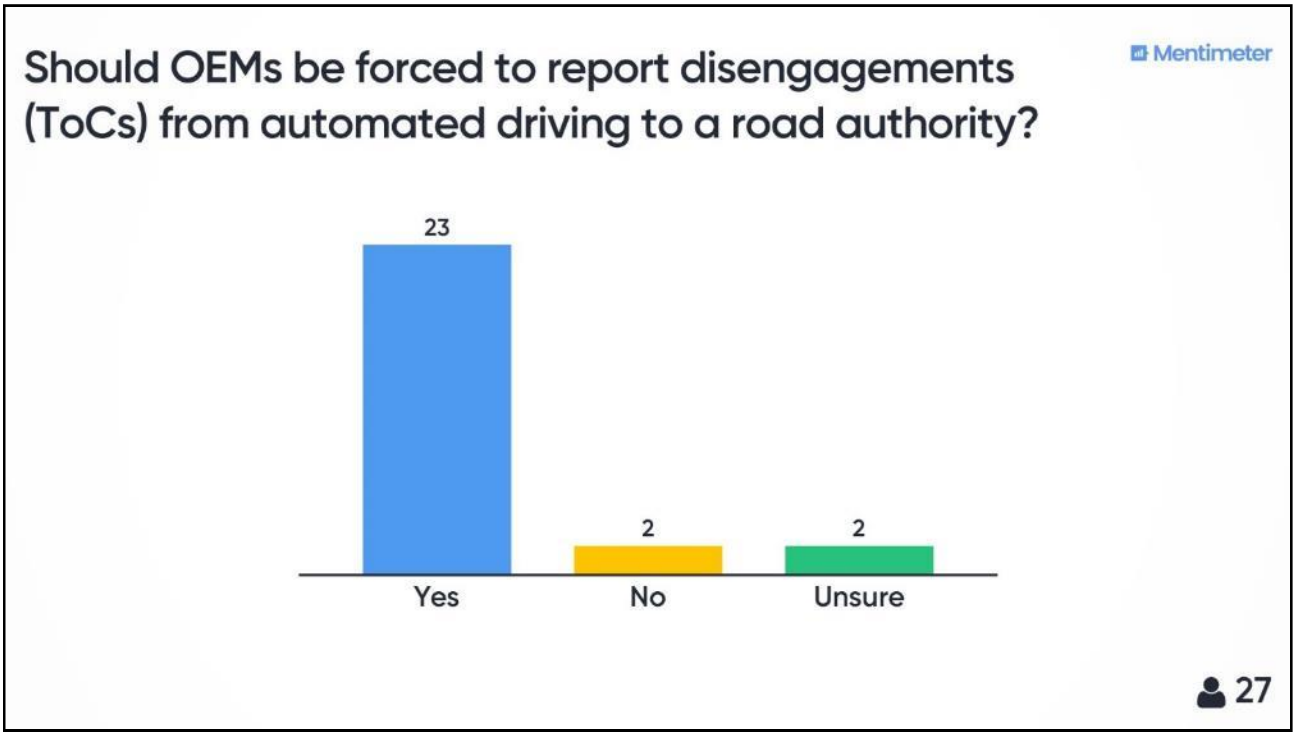

Mentimeter
LEVEL 0
There are no autonomous features.
LEVEL 1
These cars can handle one task at a time, like automatic braking.
LEVEL 2
These cars would have at least two automated functions.
LEVEL 3
These cars handle "dynamic driving tasks" but might still need intervention.
LEVEL 4
These cars are officially driverless in certain environments.
LEVEL 5
These cars can operate entirely on their own without any driver presence.
6

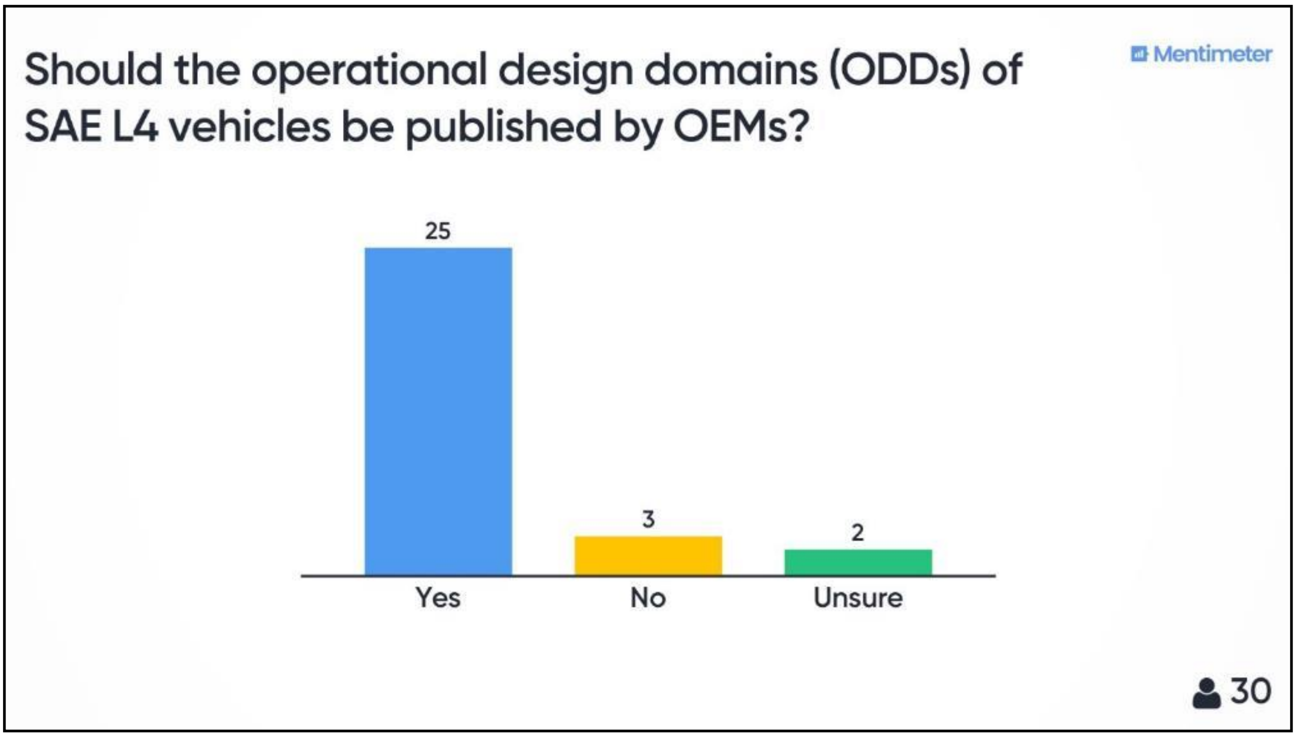

When do you expect SAE L4 vehicles to become mainstream (motorways)?
Mentimeter
1
4
7
9
3
5
2025
2030
2035
2040
2045
2050 or later
29

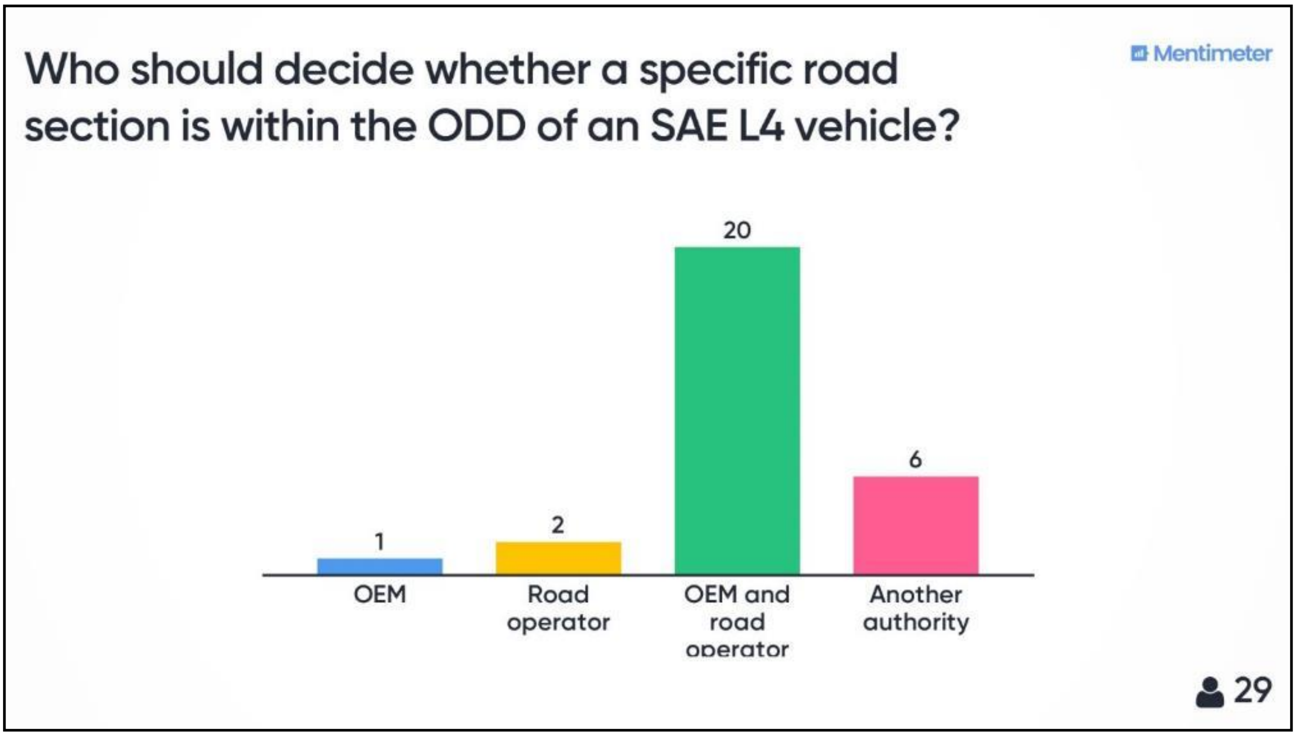

When do you expect SAE L4 vehicles to become mainstream (urban environments)?
Mentimeter
0
1
1
8
3
16
2025
2030
2035
2040
2045
2050 or later
29

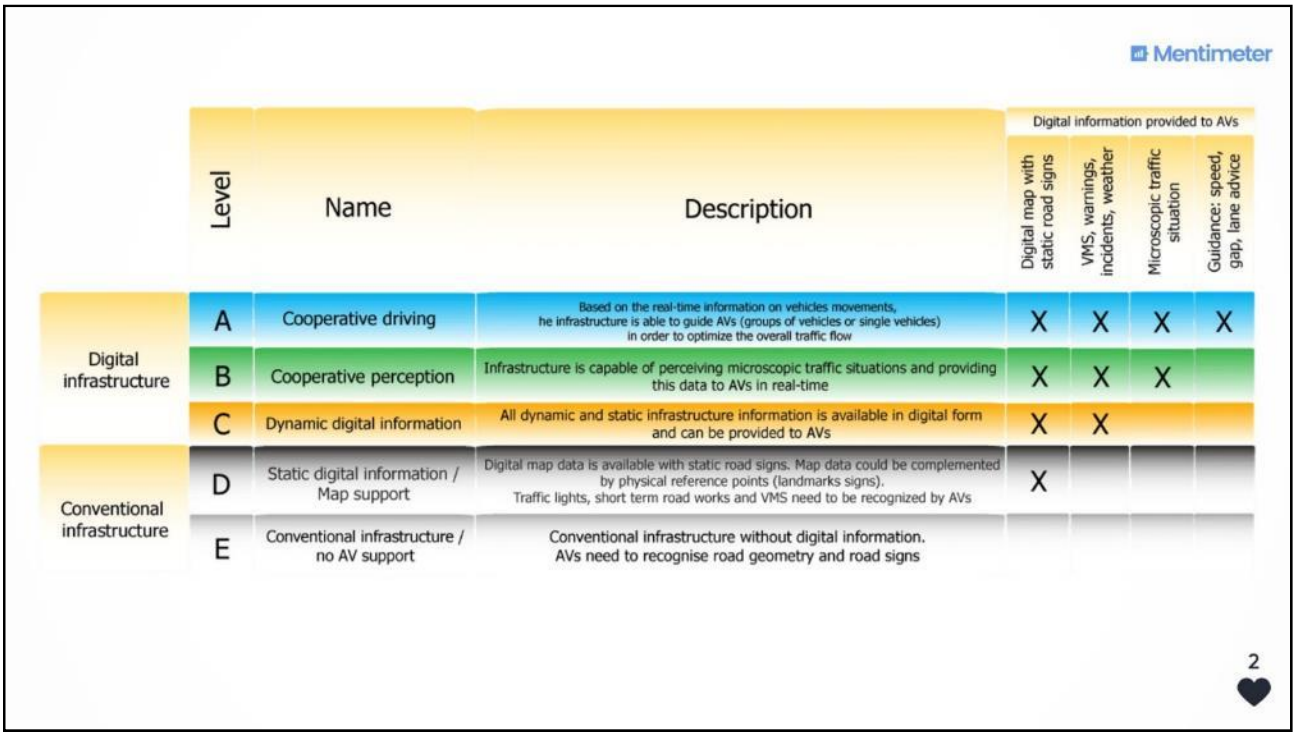

How do you expect V2X communication to be adopted?
Mentimeter
3
5
14
8
Through regulation of 4G/5G
Through regulation of G5
Through 4G/5G deployment by OEMs
Through G5 deployment by OEMs
30


Is connectivity required for some levels of automation (cf. SAE L3 and higer)?
Mentimeter
28
0
0
Yes
No
Unsure
28

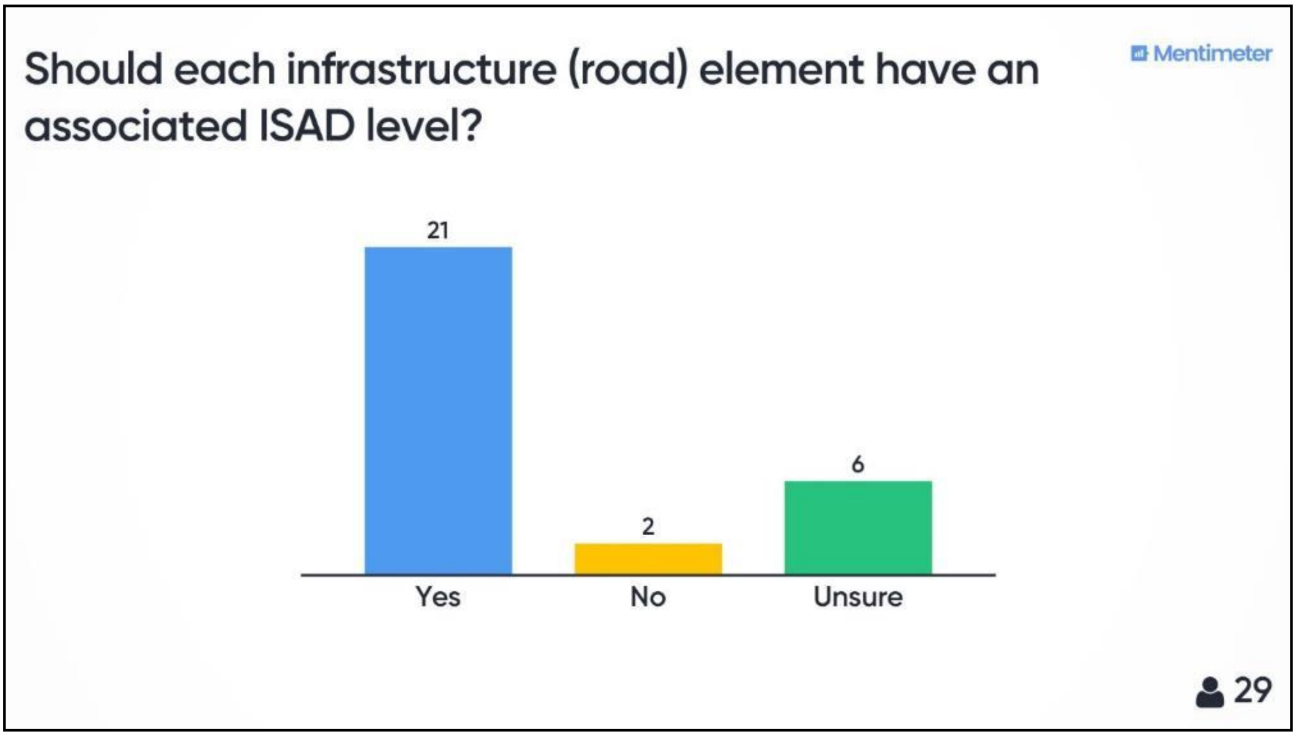

Should OEMs be forced to report disengagements (ToCs) from automated driving to a road authority?
Mentimeter
23
2
2
Yes
No
Unsure
27

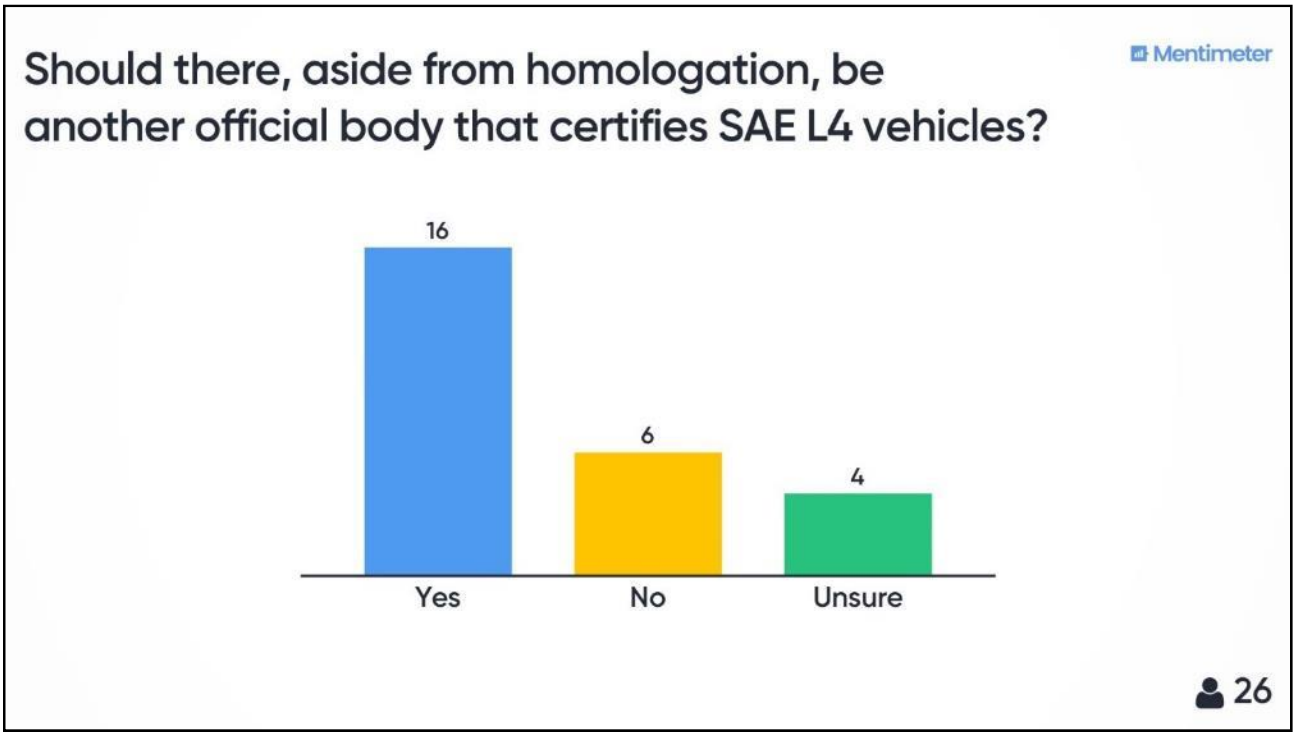

Should the operational design domains (ODDs) of SAE L4 vehicles be published by OEMs?
Mentimeter
25
3
2
Yes
No
Unsure
30

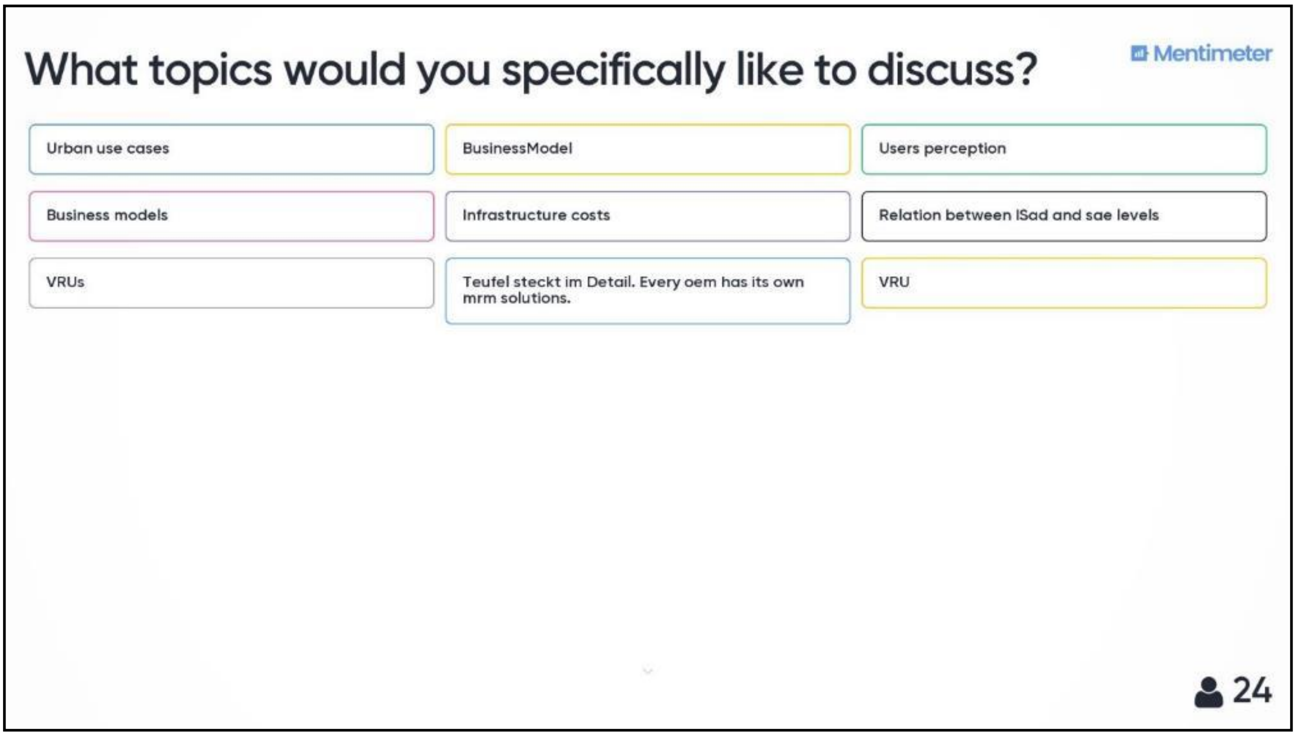

Who should decide whether a specific road section is within the ODD of an SAE L4 vehicle?
Mentimeter
1
2
20
6
OEM
Road operator
OEM and road operator
Another authority
29

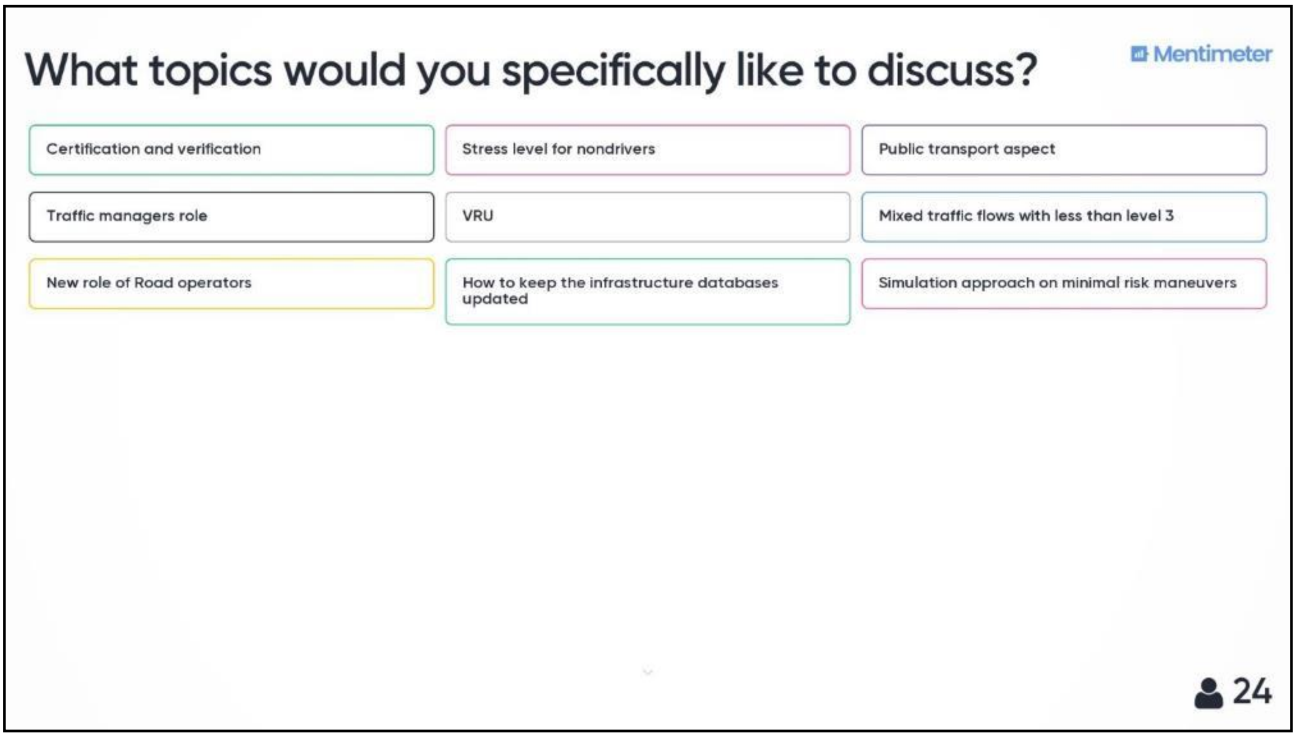


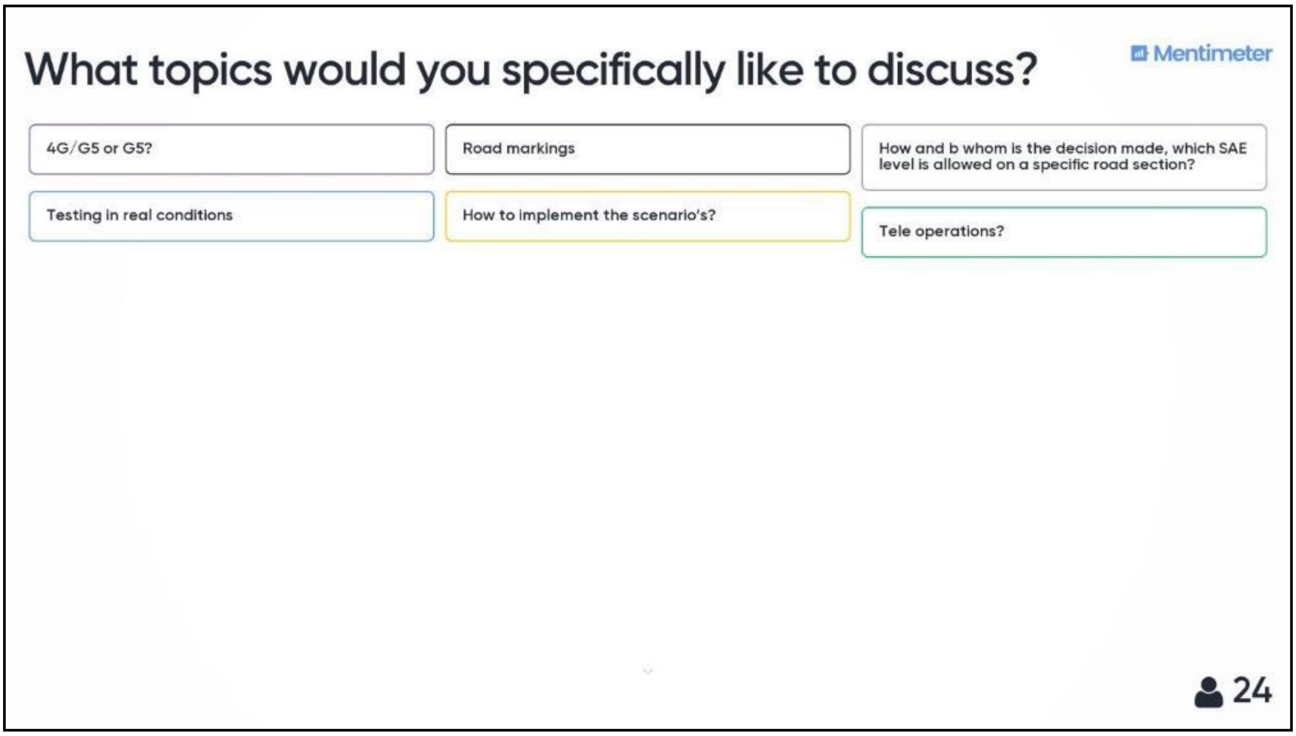
	Level	Name	Description	Digital information provided to AVs: Digital map with static road signs	VMS, warnings, incidents, weather	Microscopic traffic situation	Guidance: speed, gap, lane advice
Digital infrastructure	A	Cooperative driving	Based on the real-time information on vehicles movements, he infrastructure 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				



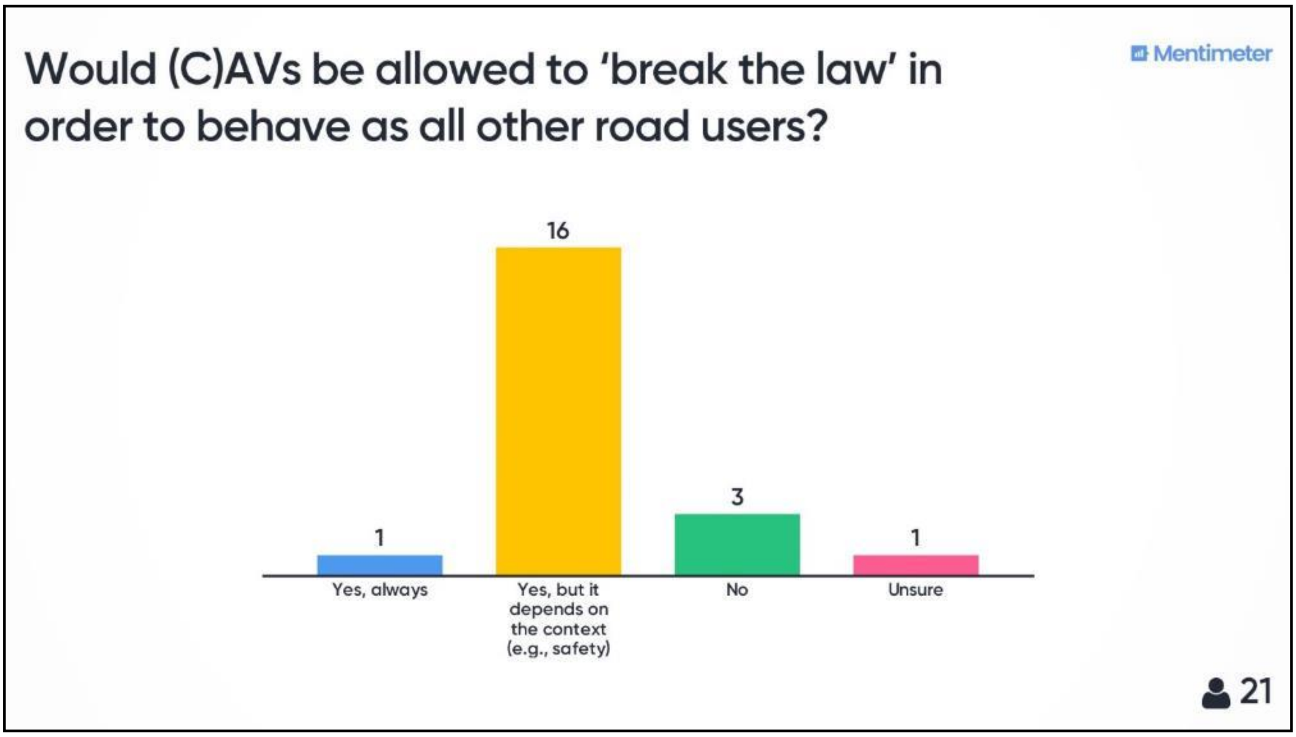

Should there, aside from homologation, be another official body that certifies SAE L4 vehicles?
Mentimeter
16
6
4
Yes
No
Unsure
26

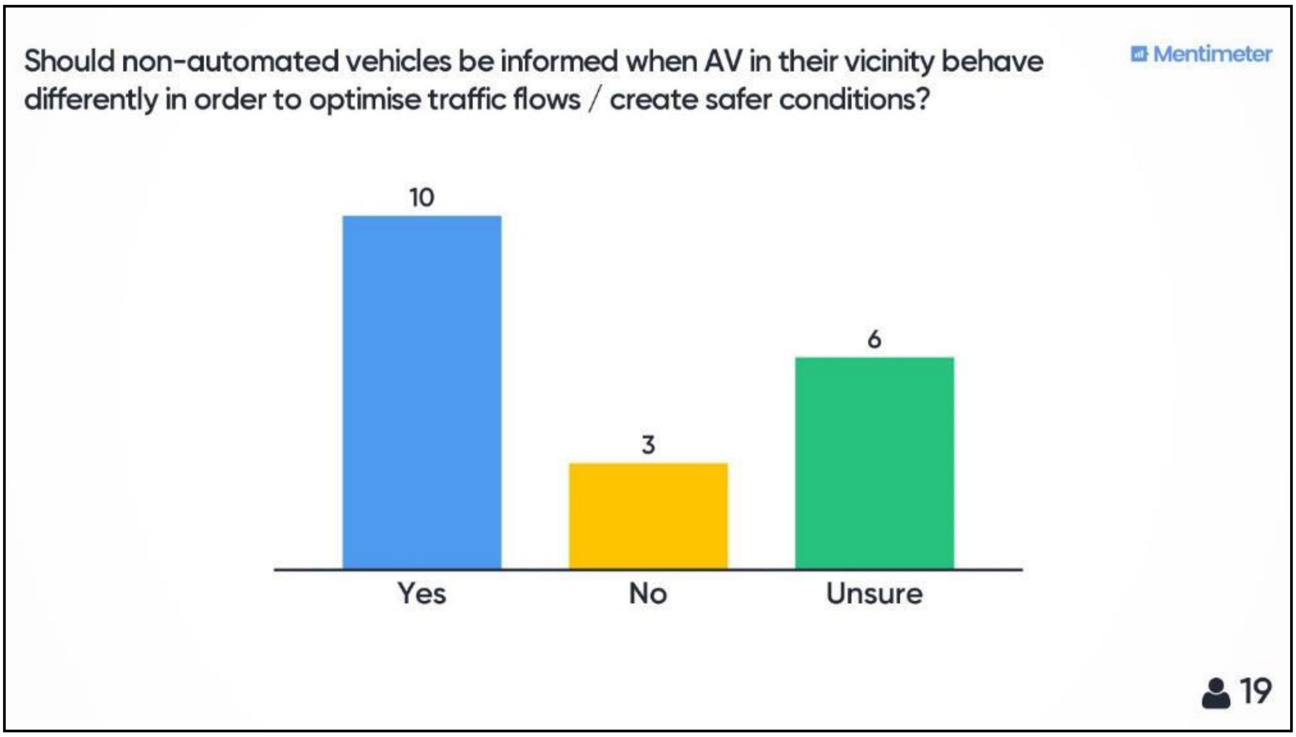

What topics would you specifically like to discuss?
Mentimeter
Urban use cases
BusinessModel
Users perception
Business models
Infrastructure costs
Relation between ISad and sae levels
VRUs
Teufel steckt im Detail. Every oem has its own mrm solutions.
VRU
24

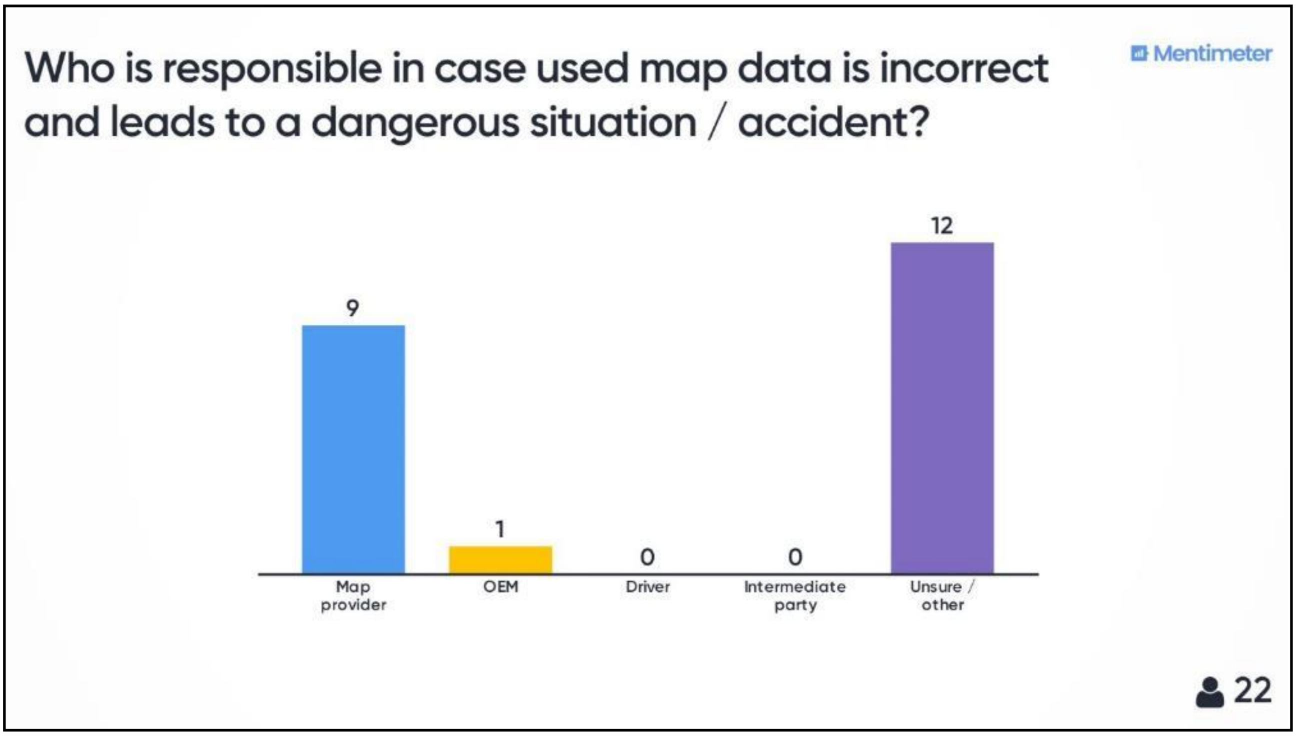

What topics would you specifically like to discuss?
Mentimeter
Certification and verification
Stress level for nondrivers
Public transport aspect
Traffic managers role
VRU
Mixed traffic flows with less than level 3
New role of Road operators
How to keep the infrastructure databases updated
Simulation approach on minimal risk maneuvers
24

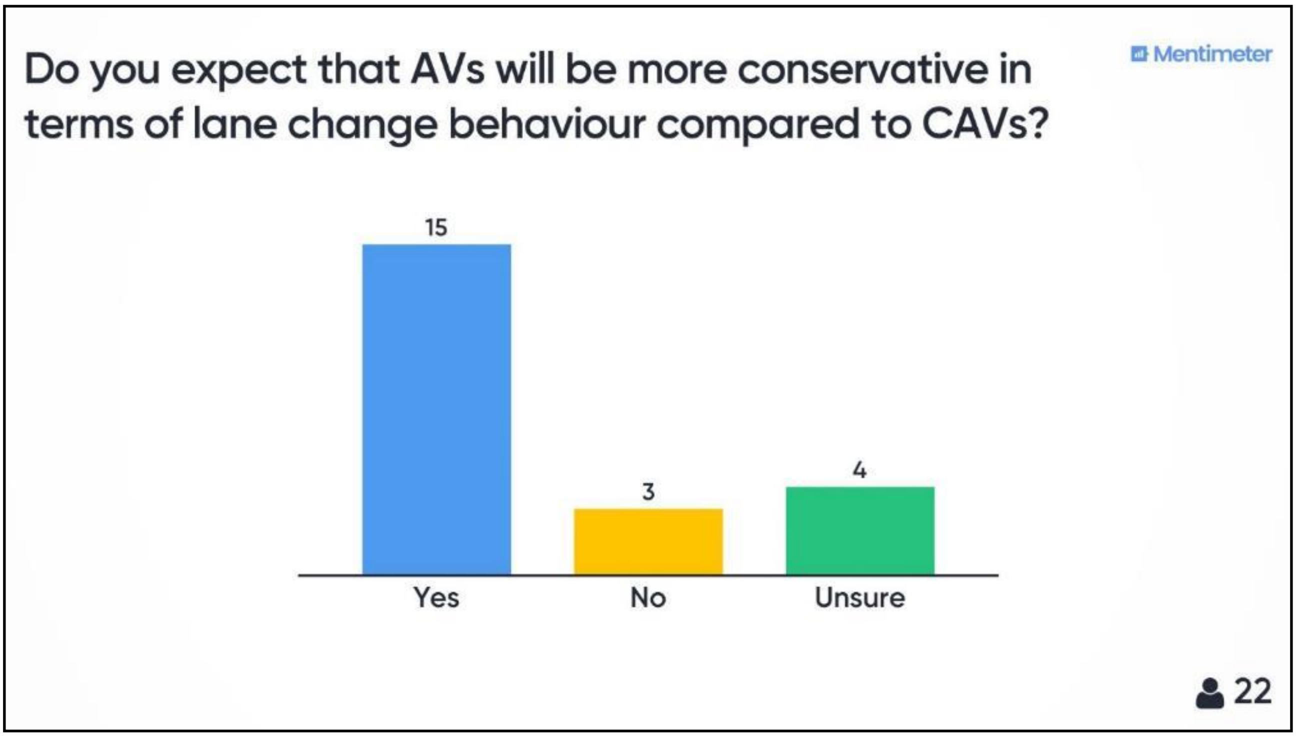

What topics would you specifically like to discuss?
Mentimeter
4G/G5 or G5?
Road markings
How and b whom is the decision made, which SAE level is allowed on a specific road section?
Testing in real conditions
How to implement the scenario's?
Tele operations?
24

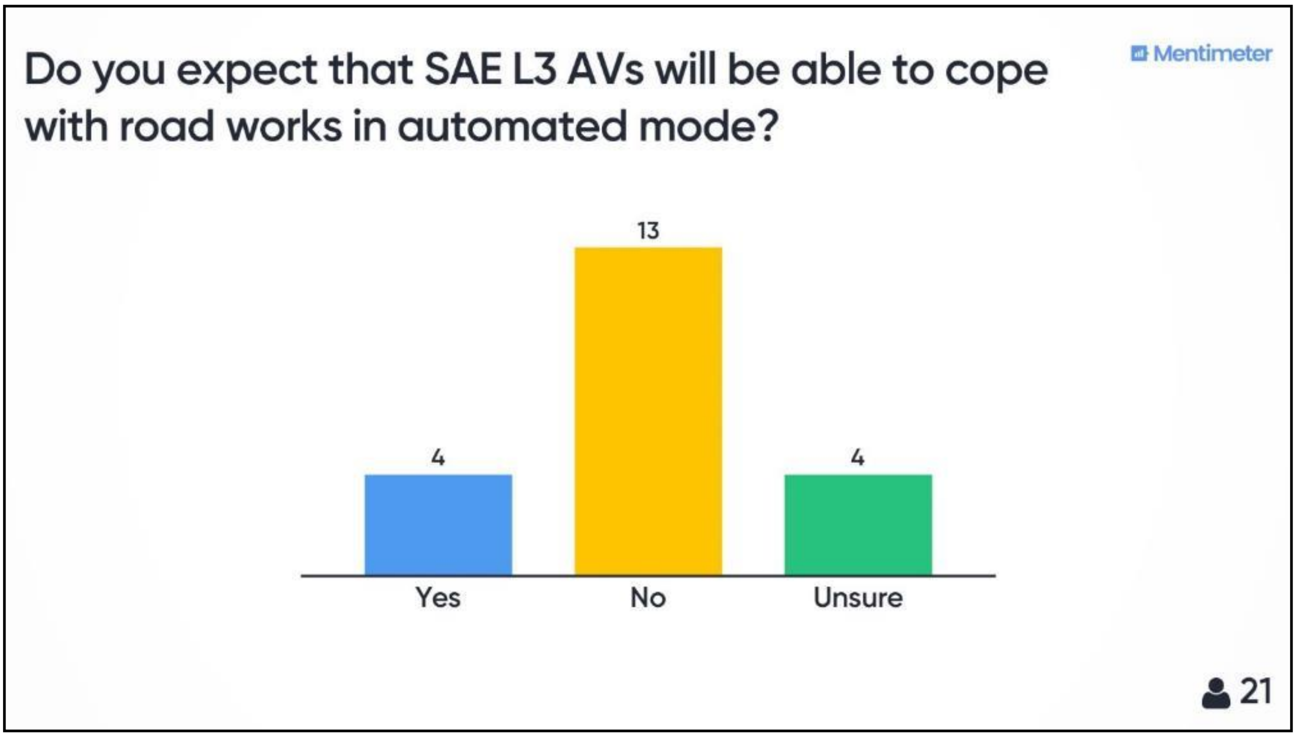
B.2 Second session results

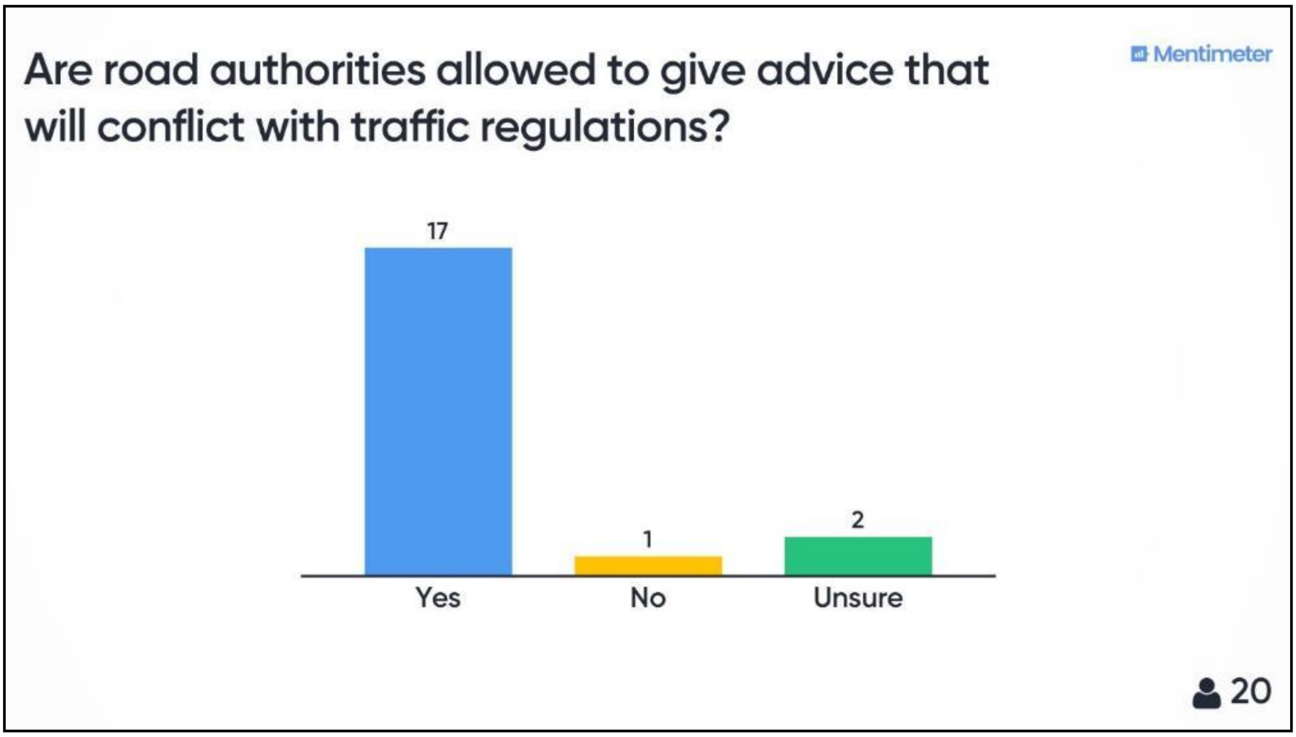


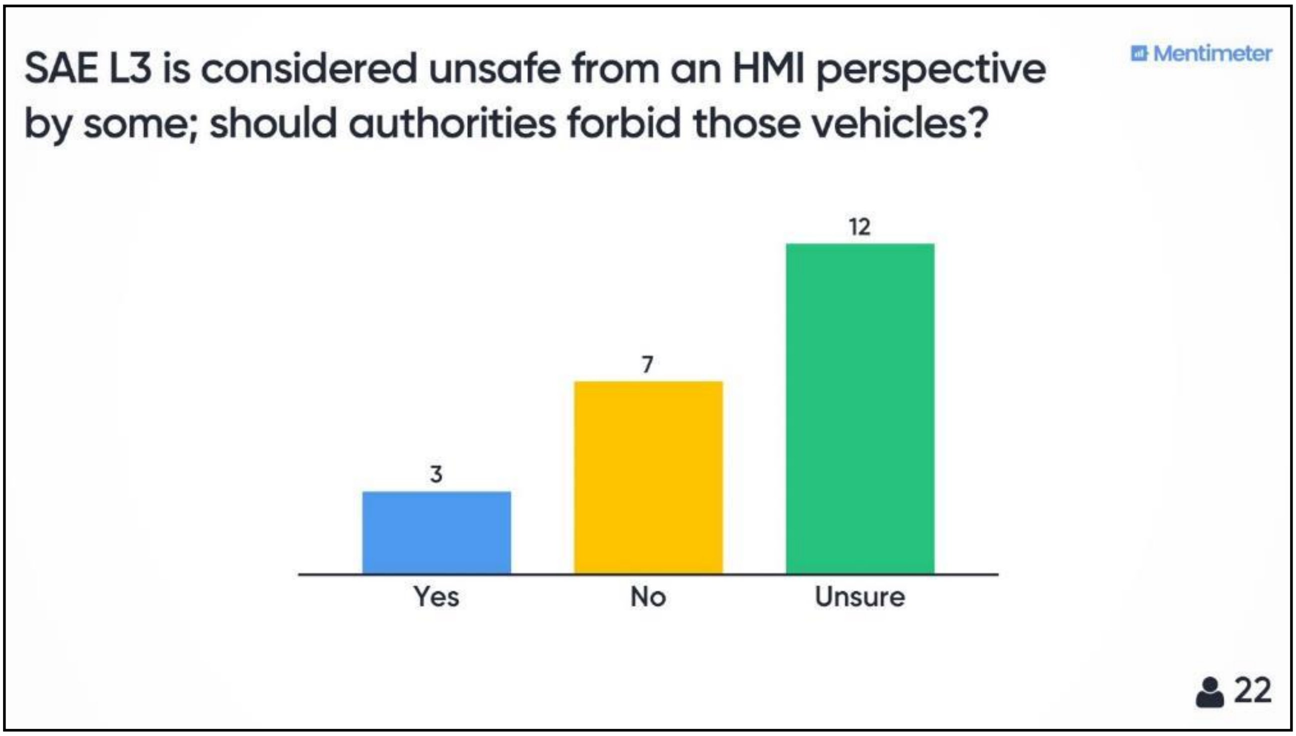

Should non-automated vehicles be informed when AV in their vicinity behave differently in order to optimise traffic flows / create safer conditions?
Mentimeter
10
3
6
Yes
No
Unsure
19

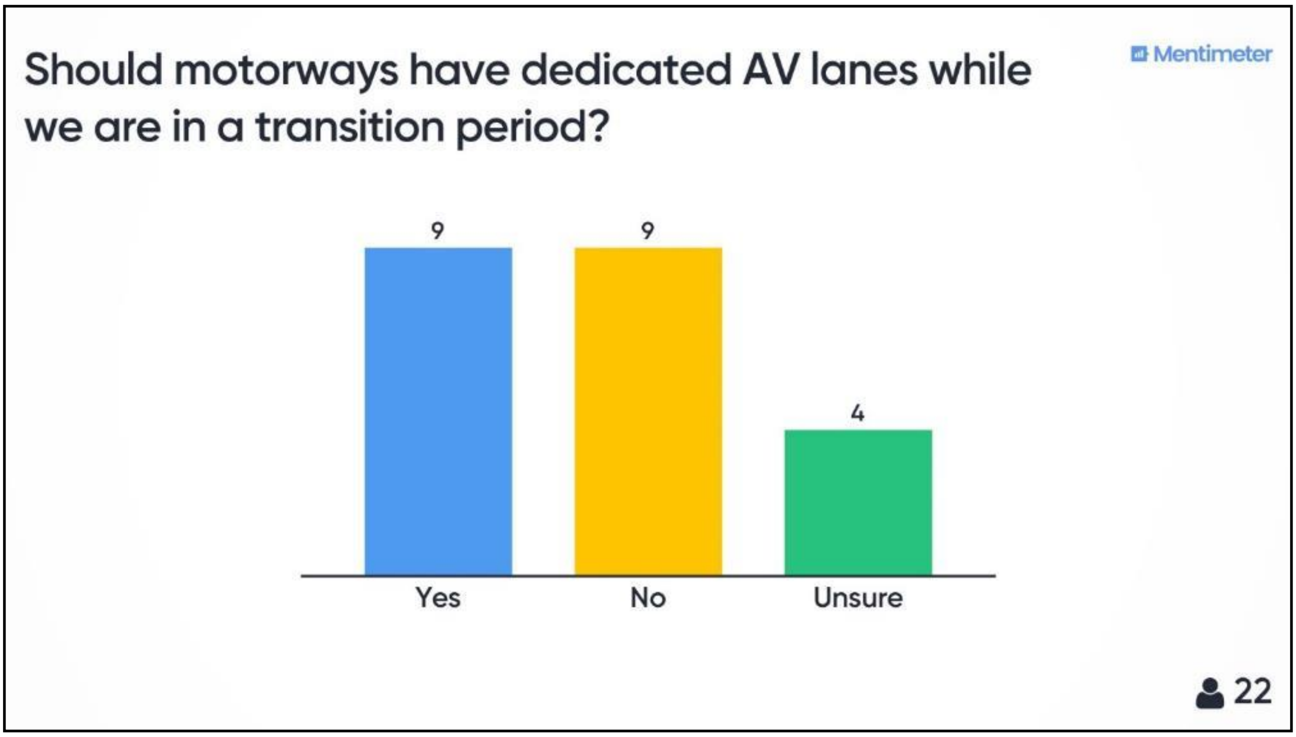

Who is responsible in case used map data is incorrect and leads to a dangerous situation / accident?
Mentimeter
9
1
0
0
12
Map provider
OEM
Driver
Intermediate party
Unsure / other
22

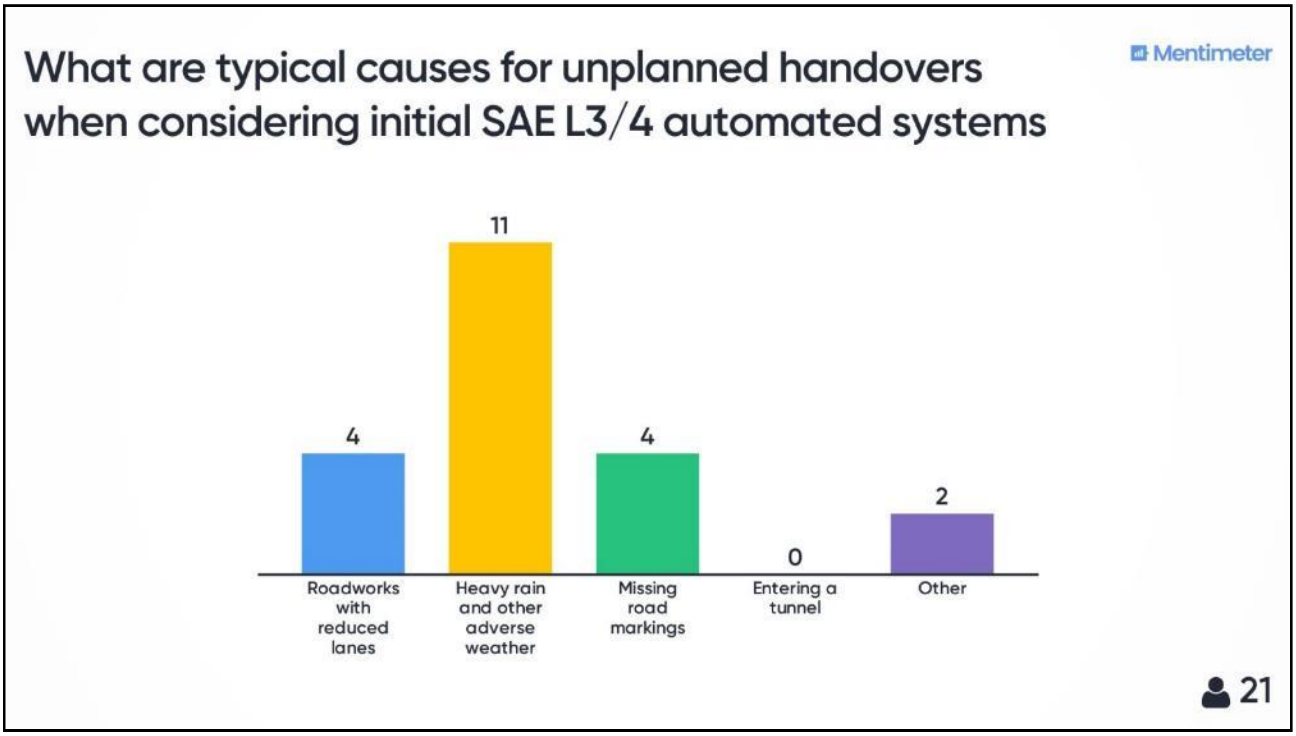

Do you expect that AVs will be more conservative in terms of lane change behaviour compared to CAVs?
Mentimeter
15
3
4
Yes
No
Unsure
22

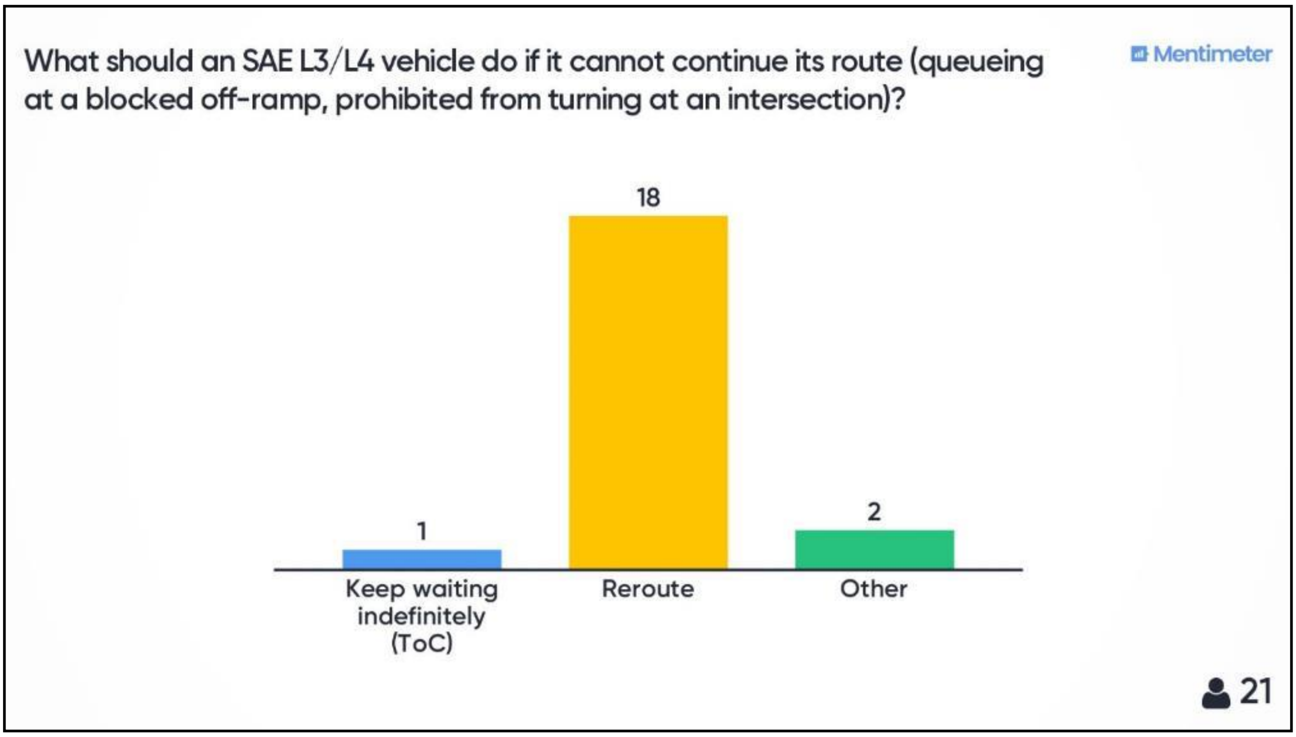

Do you expect that SAE L3 AVs will be able to cope with road works in automated mode?
Mentimeter
4
13
4
Yes
No
Unsure
21

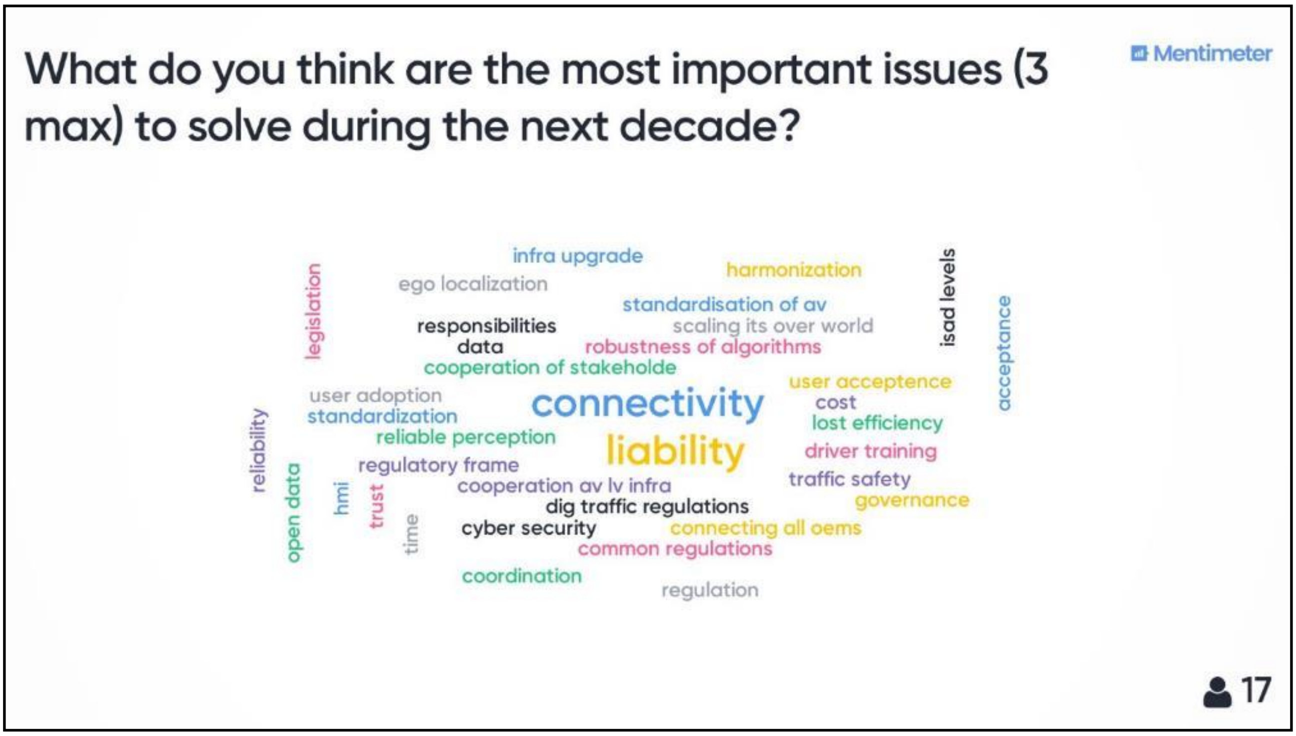

Are road authorities allowed to give advice that will conflict with traffic regulations?
Mentimeter
17
1
2
Yes
No
Unsure
20


SAE L3 is considered unsafe from an HMI perspective by some; should authorities forbid those vehicles?
Mentimeter
12
7
3
Yes
No
Unsure
22


Should motorways have dedicated AV lanes while we are in a transition period?
Mentimeter
9
9
4
Yes
No
Unsure
22

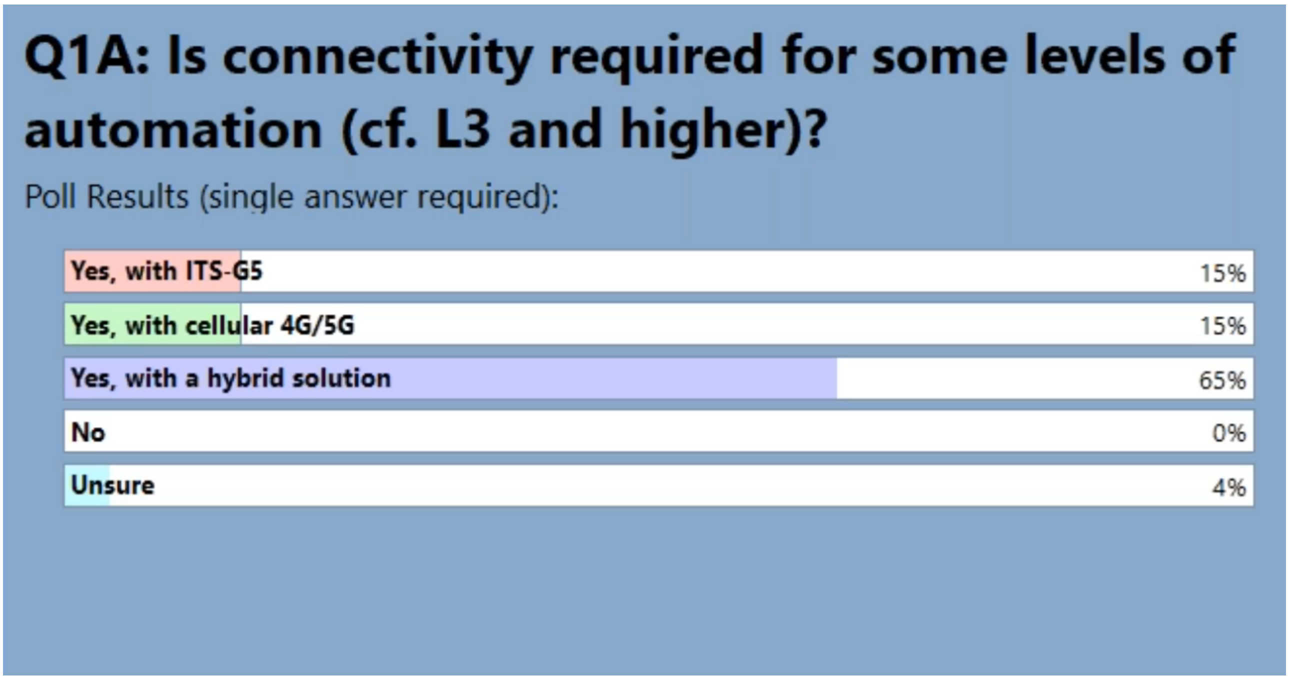

What are typical causes for unplanned handovers when considering initial SAE L3/4 automated systems
Mentimeter
4
11
4
0
2
Roadworks with reduced lanes
Heavy rain and other adverse weather
Missing road markings
Entering a tunnel
Other
21

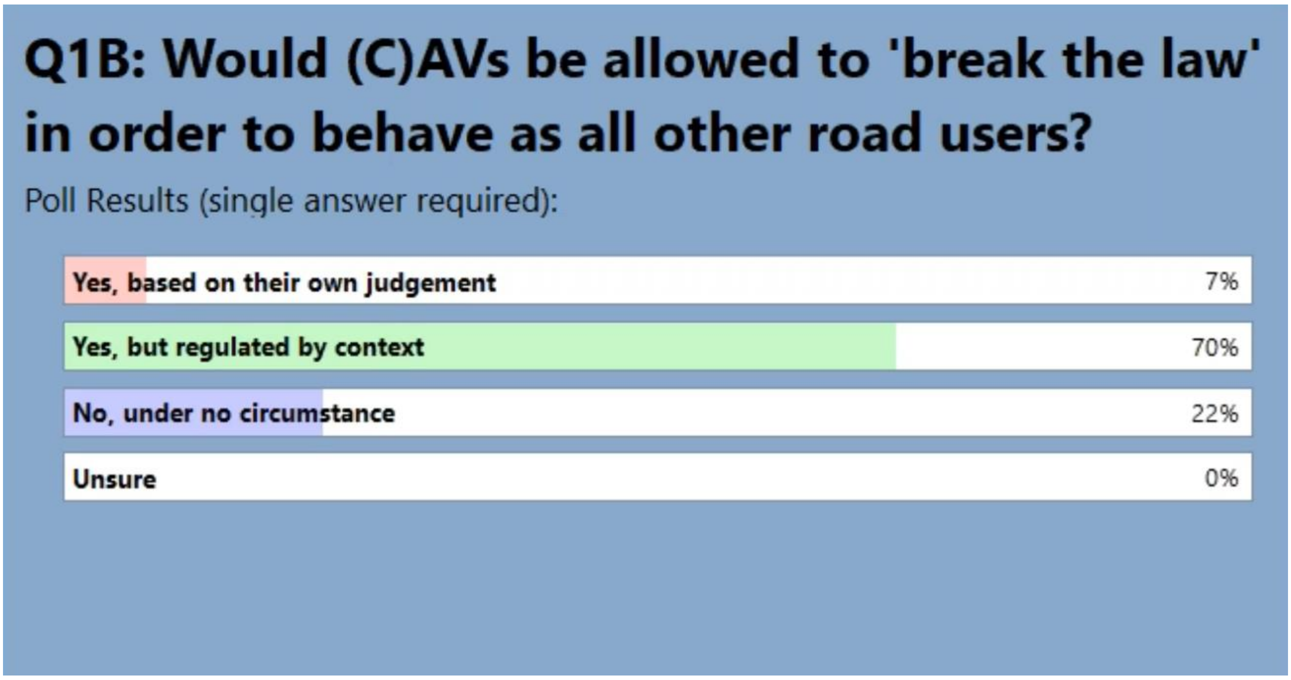

What should an SAE L3/L4 vehicle do if it cannot continue its route (queueing at a blocked off-ramp, prohibited from turning at an intersection)?
Mentimeter
1
Keep waiting indefinitely (ToC)
18
Reroute
2
Other
21

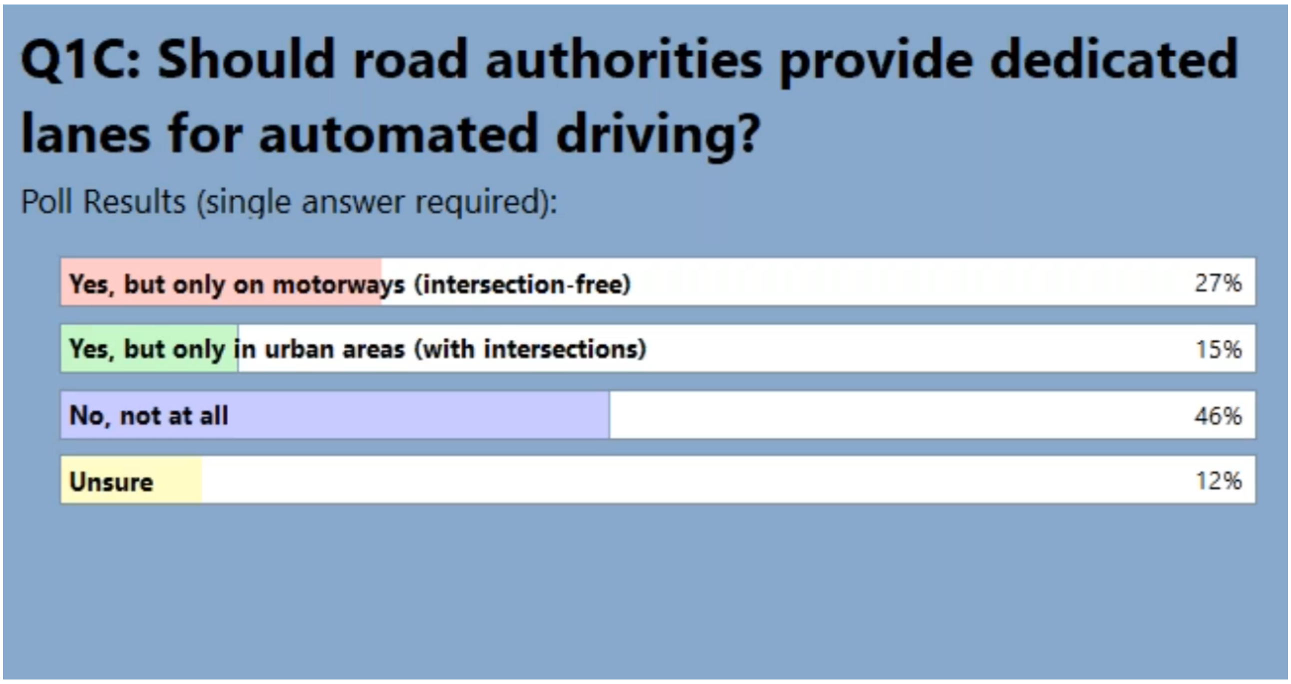

What do you think are the most important issues (3 max) to solve during the next decade?
Mentimeter
infra upgrade
harmonization
ego localization
standardisation of av
responsibilities
scaling its over world
data
robustness of algorithms
cooperation of stakeholde
legislation
isad levels
acceptance
user adoption
standardization
connectivity
user acceptence
cost
lost efficiency
reliable perception
liability
driver training
regulatory frame
traffic safety
cooperation av lv infra
governance
dig traffic regulations
cyber security
connecting all oems
common regulations
coordination
regulation
reliability
open data
hmi
trust
time
17

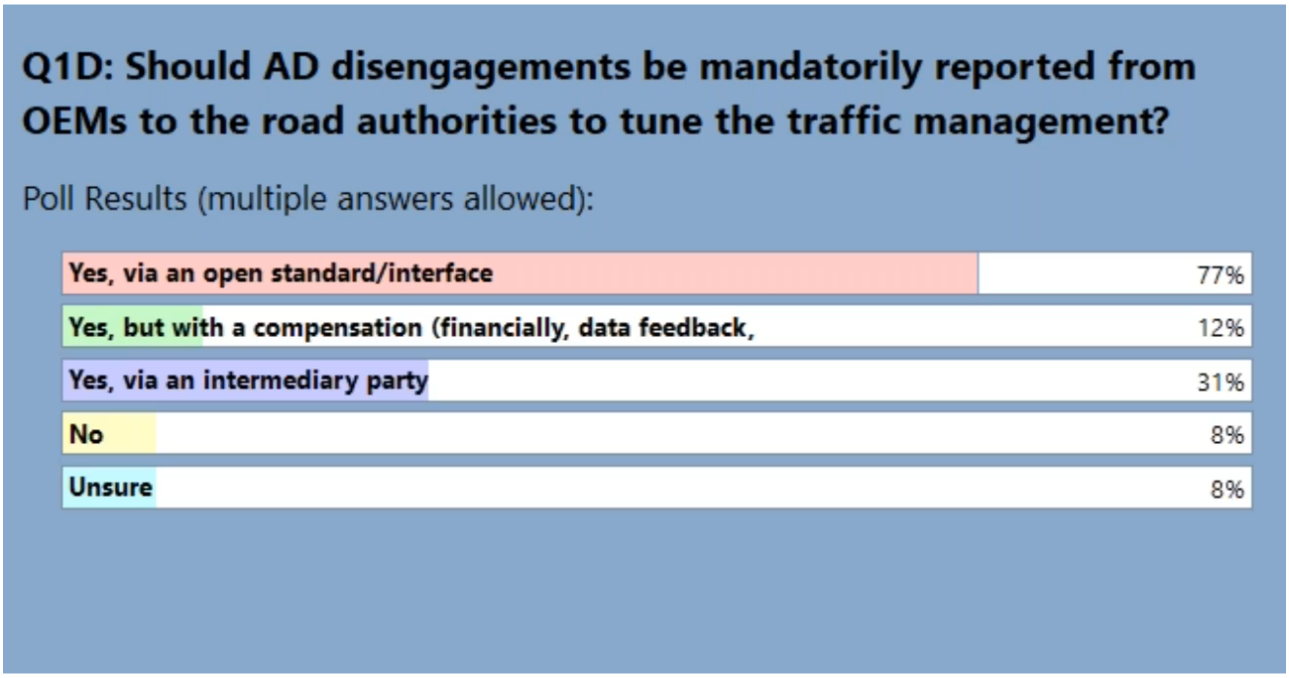
Appendix C: Detailed survey results TransAID final event, stakeholder workshop, 2 July 2020, online

C.1 First session results: digital infrastructure

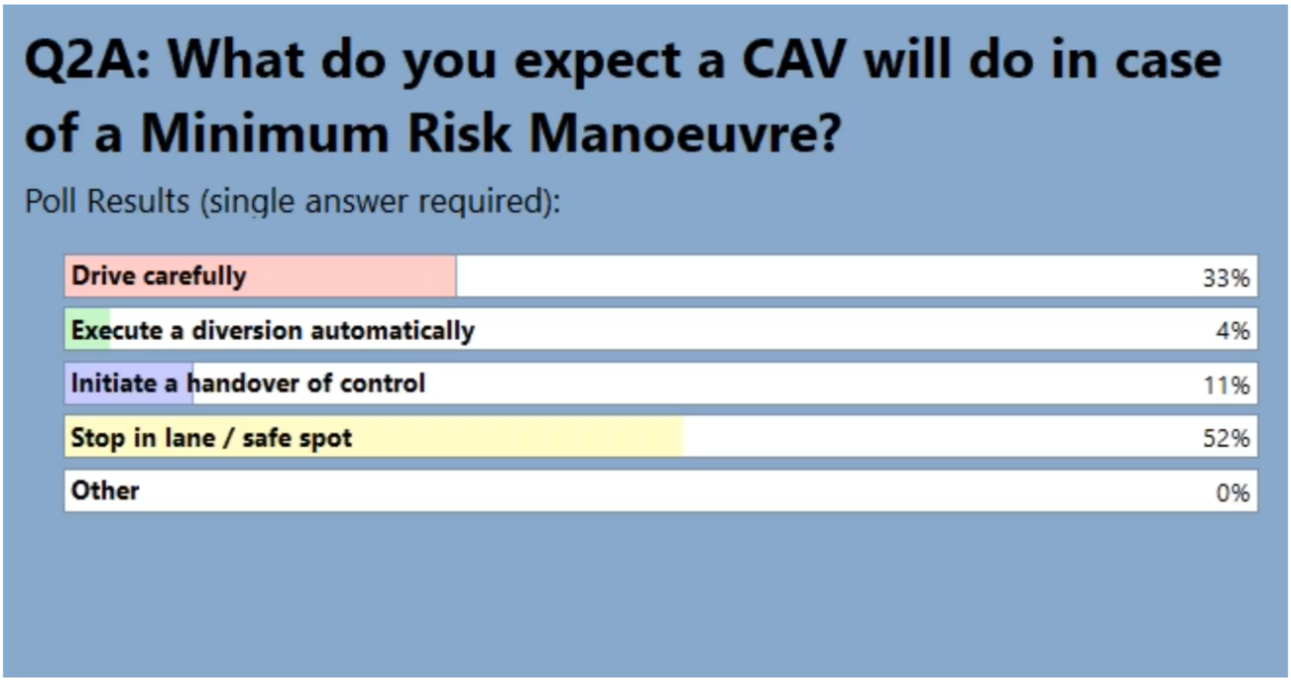


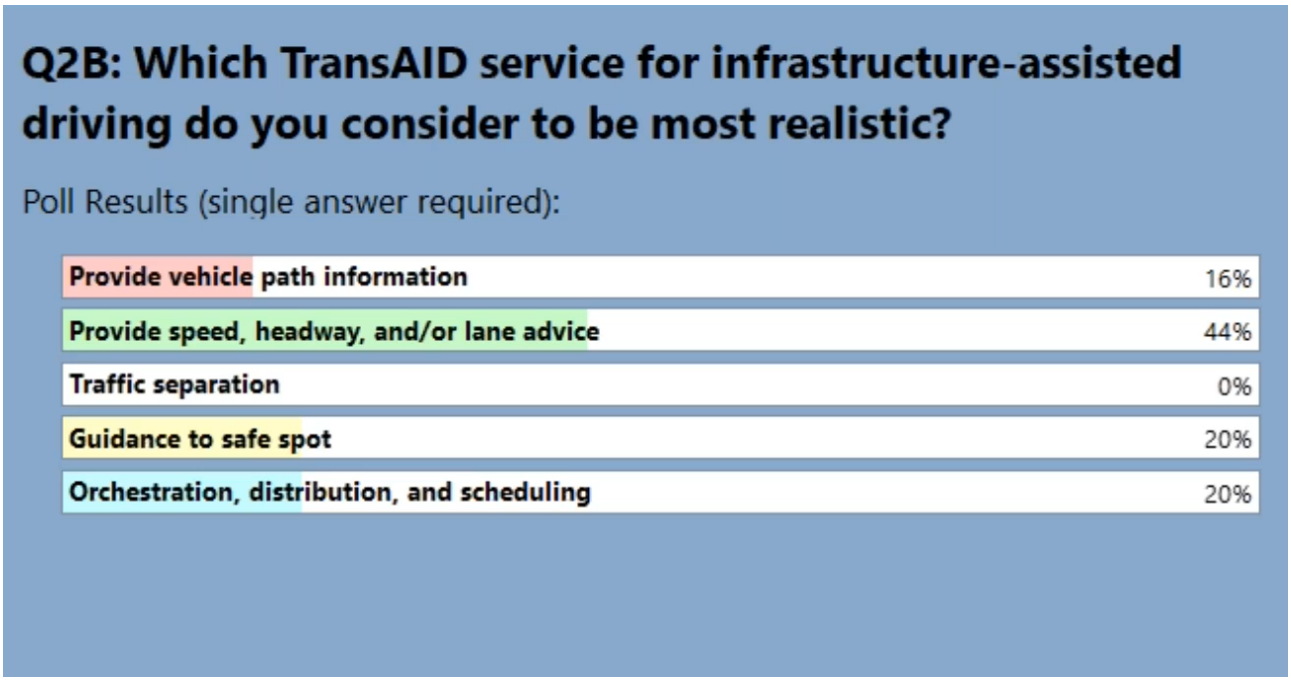


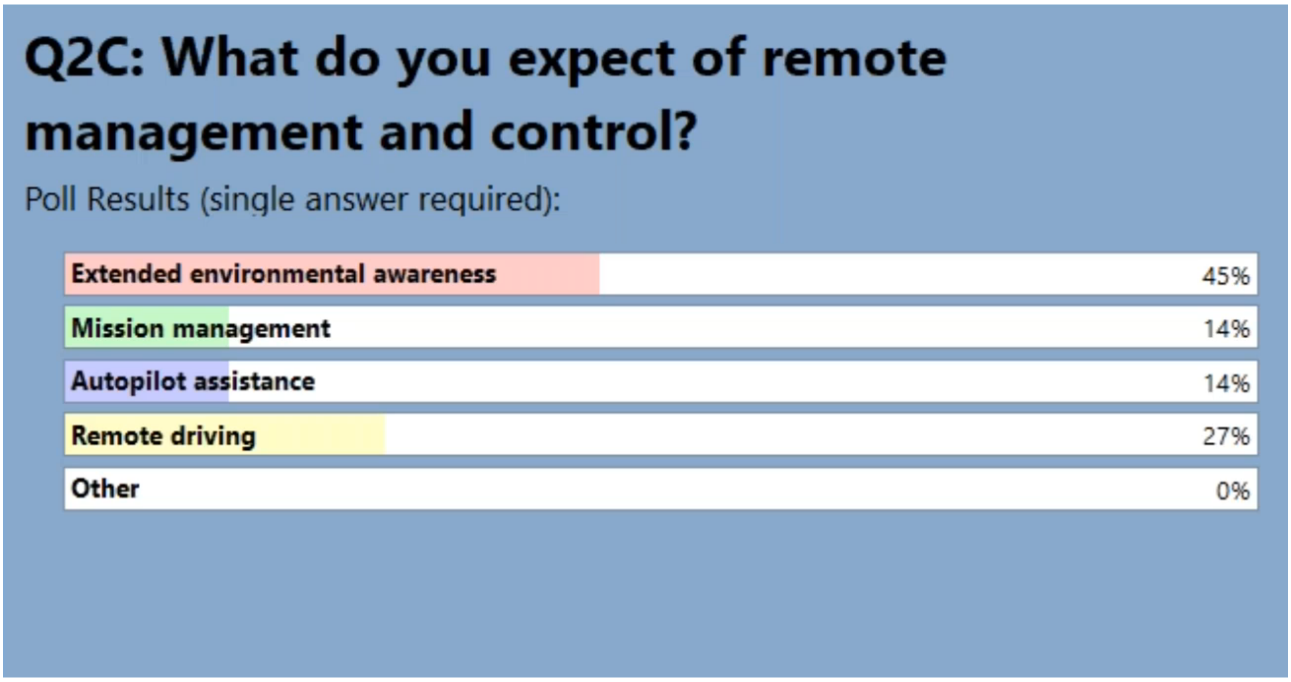

Q1C: Should road authorities provide dedicated lanes for automated driving?
Poll Results (single answer required):
Yes, but only on motorways (intersection-free)
27%
Yes, but only in urban areas (with intersections)
15%
No, not at all
46%
Unsure
12%

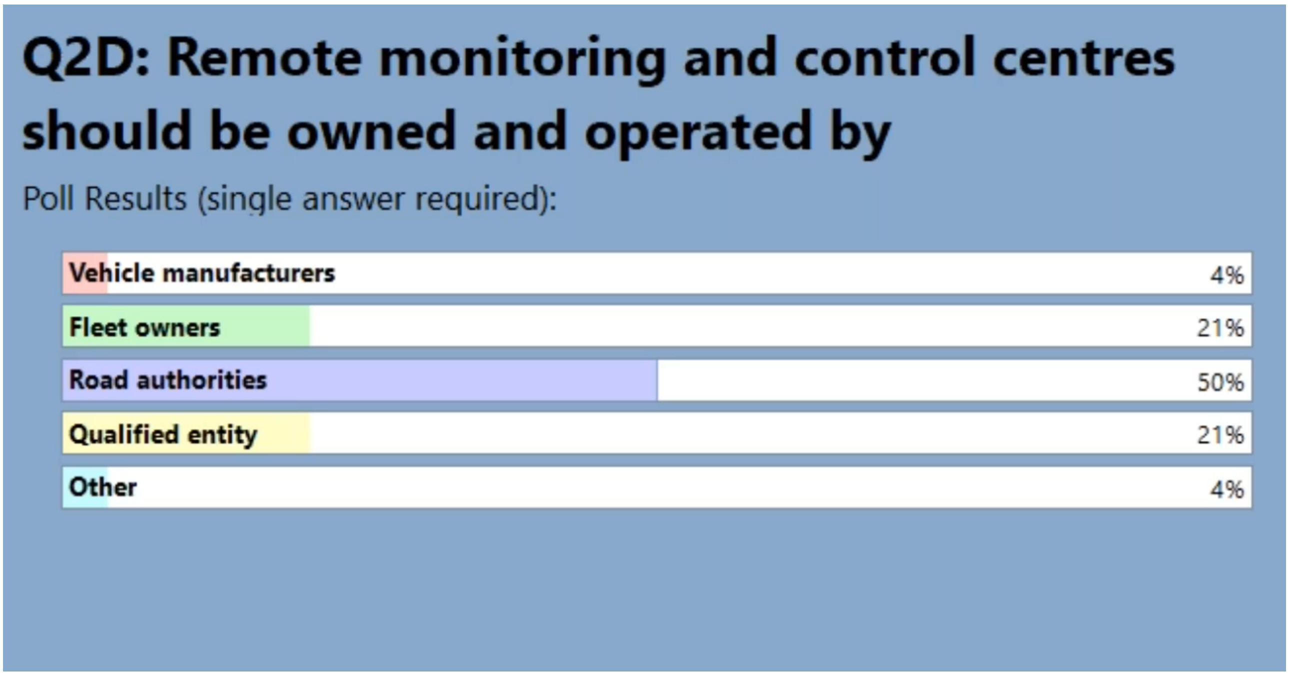

Q1D: Should AD disengagements be mandatorily reported from OEMs to the road authorities to tune the traffic management?
Poll Results (multiple answers allowed):
Yes, via an open standard/interface
77%
Yes, but with a compensation (financially, data feedback,
12%
Yes, via an intermediary party
31%
No
8%
Unsure
8%

C.2 Second session results: remote management

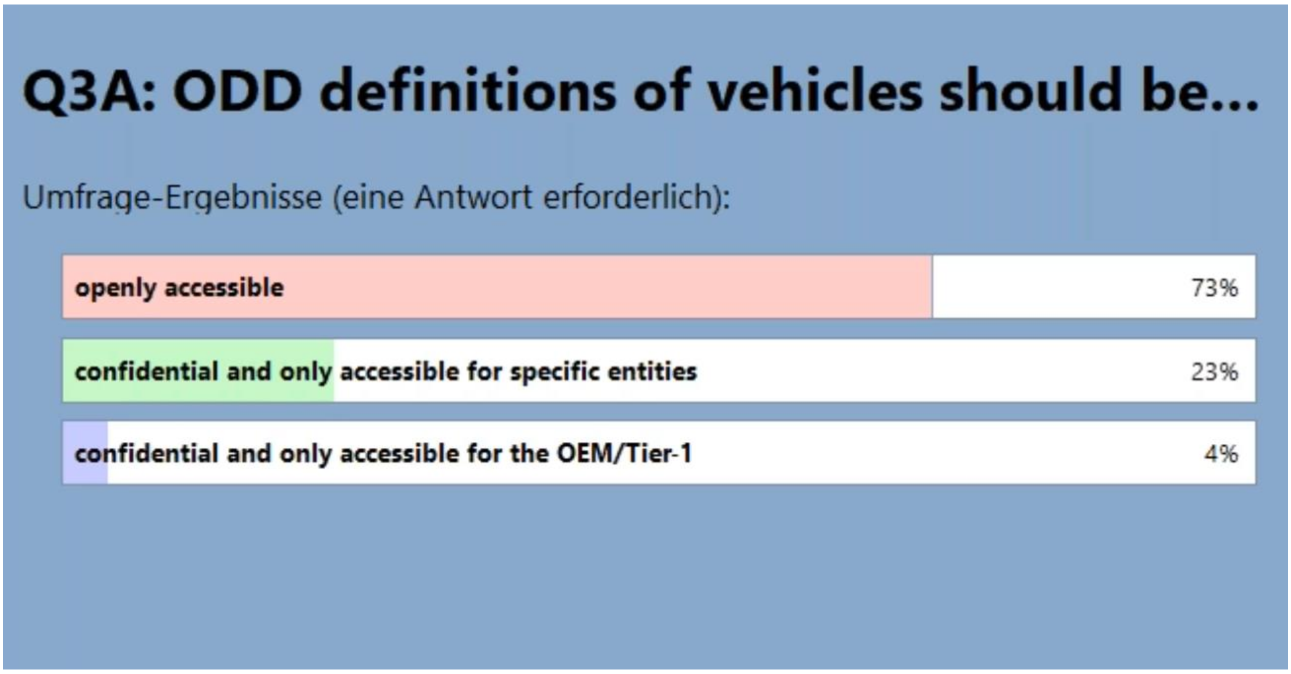


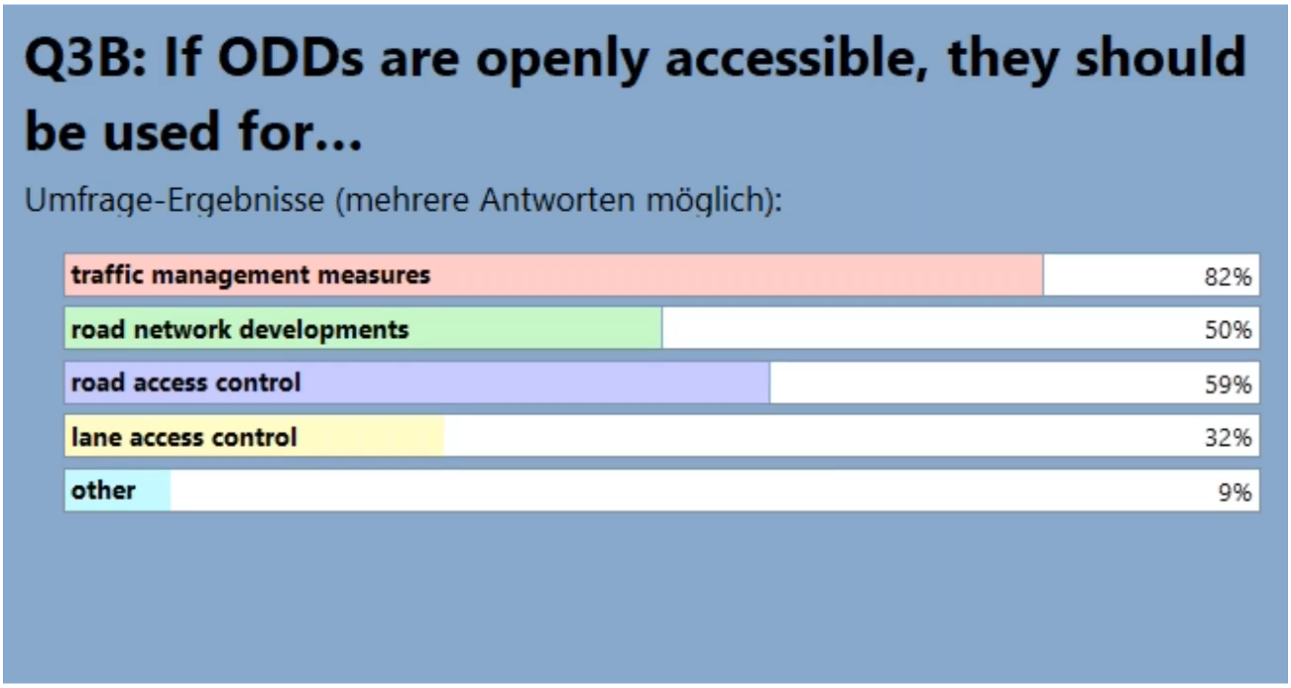


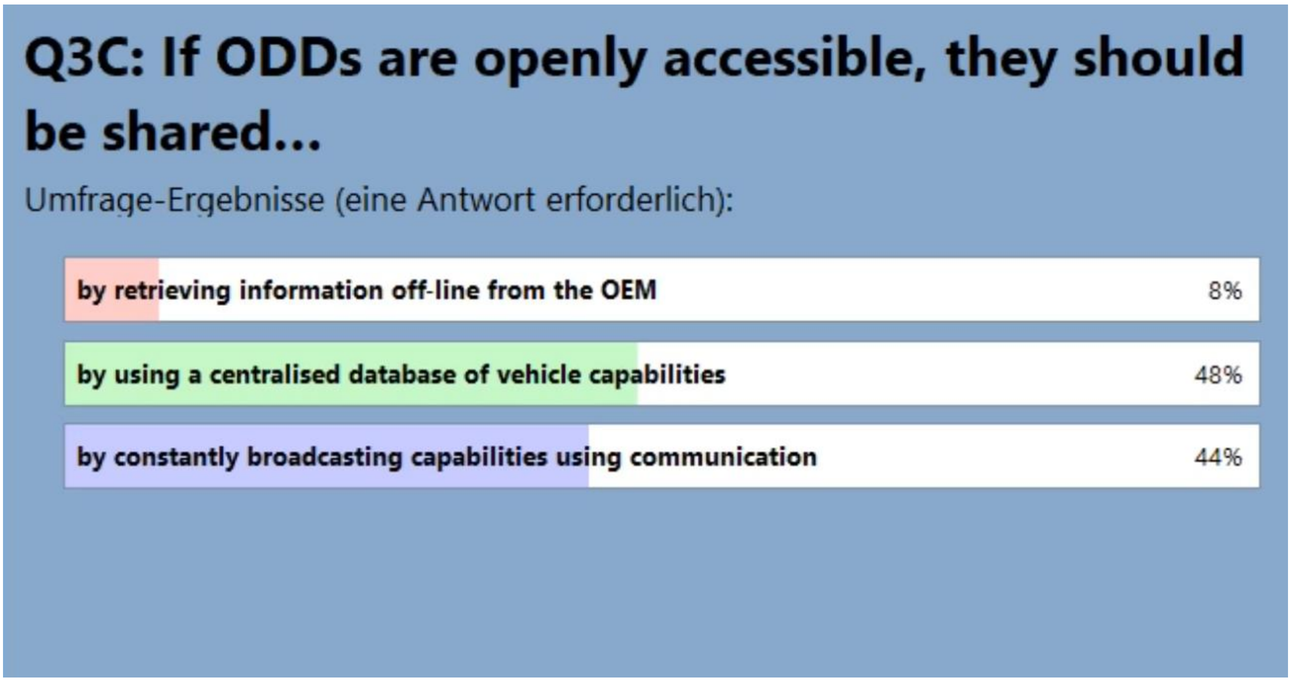

Q2C: What do you expect of remote management and control?
Poll Results (single answer required):
Extended environmental awareness
45%
Mission management
14%
Autopilot assistance
14%
Remote driving
27%
Other
0%


Q2D: Remote monitoring and control centres should be owned and operated by
Poll Results (single answer required):
Vehicle manufacturers
4%
Fleet owners
21%
Road authorities
50%
Qualified entity
21%
Other
4%

C.3 Third session results: operational design domain & road classification






Q3C: If ODDs are openly accessible, they should be shared...
Umfrage-Ergebnisse (eine Antwort erforderlich):
by retrieving information off-line from the OEM
8%
by using a centralised database of vehicle capabilities
48%
by constantly broadcasting capabilities using communication
44%


Q3D: Cities/Road authorities should use budget for automation readiness best to...
Umfrage-Ergebnisse (eine Antwort erforderlich):
Categorise roads according to ISAD levels
12%
Enhance the quality of roads
12%
Equip roads/intersections with communication technology
42%
Equip roads/intersections with sensors to enhance efficiency
35%