IAMTS (International Alliance for Mobility Testing and Standardization)

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Background:

The world of automotive transportation is currently going through the largest transition phase since the invention of the car driven by digitalization and electrification which help implement on the one side new business models but on the other side also comes with new infrastructure requirements, ultimately this will lead to new opportunities how we can organize our time while we are driving as well as how we organize our life around transportation and at the same time the society will be enabled to contribute to a more sustainable use of natural resources utilizing renewable energy for mobility.

It is important to note that within the last 20 years the world production of cars nearly doubled and the commercial use of vehicles is about 25%. There is no doubt that the dynamic growth of the Chinese automotive market was a significant driver of this development.

Vehicle safety is a primary concern to be considered in the development of cars, in particular more than 1 million people are killed per year on the road and more then 20 million per year are seriously impacted by road traffic injuries.

In particular with the development of connected and automated vehicles, many countries developed a “Vision Zero” strategy, which basically implies that through technical progress ultimately nobody has to die any longer in a traffic accident.

In particular in densely populated urban areas the congestion situation during peak traffic hours leads to massive losses in both personal and business productivity which is one of the major drivers for people being interested in highly automated driving as well as the huge success of rideshare services. The trend of online shopping which comes with home deliveries as well as the popularity of rideshare services come with the risk of additional traffic which contributes to the congestion in urban areas.

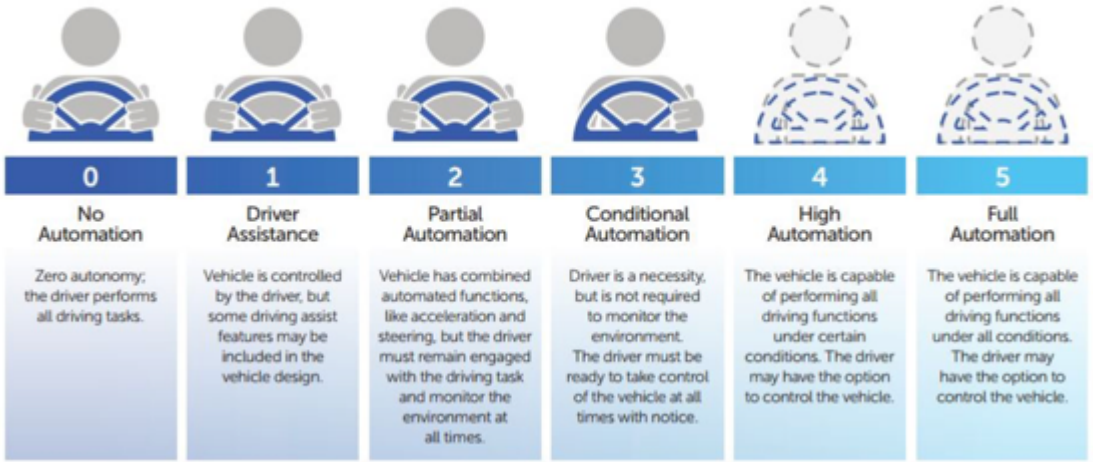
It is important to understand that the projected energy consumption for transportation continues to grow, predominantly driven by Non-OECD countries. The primary consumer of energy in transportation are passenger light duty vehicles (PLDV).
The pressure to replace fossil fuel sources with renewable energy sources in transportation will also increase once vehicles with electrified powertrains reach a significant market share.

The use of cyberphysical testbeds to build a highly automated mobility-as-a-service ecosystem :

It is to be expected that over the next 10 years we will see a shift in consumer behavior in terms of transportation because technology will allow a service-centric model where the service delivery can be highly automated.

As we are shifting to a highly automated mobility-as-a-service mobility ecosystem the existing automotive supplier system will also be changed and established Automotive OEM's will be challenged by new competitors.

Until the development of automated driving became a top priority for many OEM's, the public perception of automotive testing was very much centered on crash safety and vehicle emissions.



SAE Automation Levels, Source: SAE International

Testing vehicles for SAE Automation Level 4 and 5 requires a new approach how the vehicles are being tested because the responsibility to control the vehicle is handed over from a human being to a machine.

The key challenge is to replicate Operational Design Domains (ODD's) in physical testbeds (whether in closed or open test environments) that fit to the driving capabilities of the Automated Driving System (ADS) to be tested. In order to simulate a specific ODD in a virtual environment, it is important to capture data from the real world environment being simulated such as road or building information in sufficient precision.

As it is impossible to accumulate sufficient physical test miles in an AV vehicle prototype on a real road system to demonstrate that their failure rate is statistically in the magnitude or lower than human failure rate (which equals to 1.06 per 100 million miles), the application of simulation tools in virtual environments for verification and validation of the ADS is crucial.

One of the main challenges of testing automated vehicles on public roads is that a situation can occur which is outside the ODD of the AV and which require manual interaction.

The vision of fully automated driving can only be fulfilled if the vehicle can handle any driving situation without limitations, but it is safe to say that such a capability would have to be proven over a very long period of time over a very large road system with a sufficient number of vehicles.

For the foreseeable future the realities of traffic will require automated and non-automated traffic participants to co-exist which means that behavioral patterns need to be well understood to ensure a high level of transportation safety. As the percentage of automated traffic participants will grow over time, the influence of automation on the behavioral patterns in traffic will become significant to a degree that it can actually influence traffic flow and fleet energy consumption at large.

A type approval or certificate of conformity (homologation) is granted to a product if it meets a minimum set of regulatory, technical and safety requirements. In many countries a type approval is required before a product can be sold. In major automotive markets such as EU and China type approval for automotive vehicles is mandatory. In other major markets such as USA a self-certification process performed by the OEM is sufficient. This means that the OEM validates that the vehicle meets the regulatory requirements and witnessing by a third party authorized by the government is not necessary. The self-certification process including proper documentation and evidence is required to demonstrate compliance. The government is authorized to test production vehicles to verify compliance.

In particular in the US testing of automated vehicles on public roads became a major regulatory topic and some US States became very progressive in introducing legislation to make public road testing of AV's legal, even without a safety driver being present when certain conditions are met.

The dynamics of supporting AV public road testing is typically driven by economic development motives to attract AV R&D activities and support companies that develop AV solutions.

Both EU and China have been more restrictive regarding AV testing on public roads than the US but they are very active in developing a regulatory framework which includes type approval. Their emphasis is to combine virtual testing, physical testing on closed tracks and public roads to achieve product certification.

As a result of the emphasis of the automotive industry to develop highly automated and fully automated vehicles, a growing number of dedicated AV test facilities are being developed worldwide. Most of those facilities are designed for shared use among different stakeholders of the smart mobility ecosystem. As indicated before, it is essential to verify and validate AV systems in cyber physical testbeds which can be established both in closed as well as in open environments to support urban, rural and highway driving.

The fundamental "language" to define and understand action and response patterns between vehicles or in more general between traffic participants – whether automated or non-automated – are driving scenarios.
Driving scenarios can be designed into virtual simulation environments and they can be validated in physical test environments.

The AV perception system will receive the data required for the planning system to decide how the vehicle should respond within specific scenarios. Machine learning algorithms need to be trained with suitable test data to translate perceived situations into correct target actions.

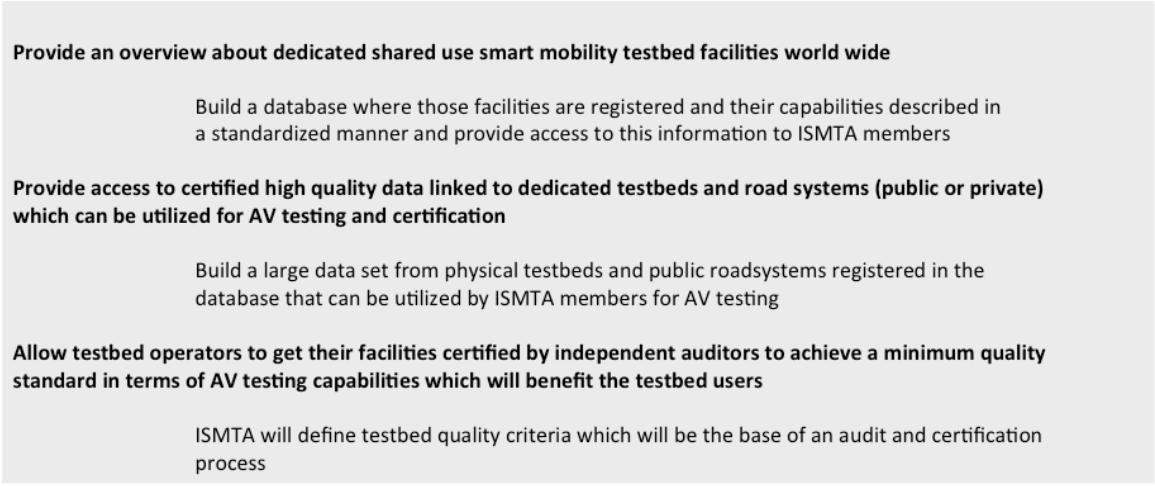
Collecting data from human-drivers on public roads, generating data within simulated scenarios and validating data from driving on closed and open physical environments with AV test vehicles will lead to an overall big test data set which can be shared among the different stakeholders being involved in developing an ADS. The sources of data can be both public and private.

In order to ensure that specific driving scenarios can be supported within a physical testbed or a public road network, a classification of the AV capabilities of the infrastructure is needed in order to be matched with the AV capabilities of the ADS to be tested (e.g. using a scenario-based approach).

Once the AV capabilities of the infrastructure and the AV capabilities of the vehicle fleet are understood in context, a highly automated mobility-as-a-service platform for well-defined ODD's can be developed.

The need to form the International Alliance for Mobility Testing and Standardization (IAMTS):

As pointed out in the previous chapter, a large number of testbeds are being established worldwide that target to enable a highly automated smart mobility ecosystem. Although the introduction of highly automated and fully automated driving system is highly competitive, the success with the consumer will depend to a strong degree on how well the mobility services can work in context. This means that highly automated mobility services need also be tested in context. It requires the use of a "common language" to understand action-response patterns for well defined driving situations. Also, regulatory compliance tests or type approval tests need to be performed in facilities that meet a minimum requirement standard in their capabilities which can help to improve the overall quality level of test facilities that offer their services in the domain of highly automated and fully automated vehicle system development and certification. Another important aspect is the availability of high quality test data to the whole developer ecosystem to avoid unfair market conditions dictated by a few powerful players.



Key problems being addressed by IAMTS

The vision, mission and value proposition of IAMTS:

To create a global community to learn, develop and share best practices for advanced mobility testing. Enable the rapid evolution of standards and certifications to ensure the safe deployment of advanced mobility systems and services.

Vision of IAMTS

To develop and grow an international portfolio of advanced mobility testbeds that meet the highest quality implementation and operational standards.

Mission of IAMTS

To support the mission of IAMTS, the registered testbeds will be regularly audited for their capabilities and operational performance by independent experts and updated by the operators within a committed timeframe.

The Alliance Value Proposition:

- Obtain unbiased evaluations of the capabilities of smart mobility testbeds
- Identify global experts that provide services to design, build, operate and utilize smart mobility testbeds
- Bring together testbed users and operators at a global scale to help develop a commonly accepted framework of regulations, test scenarios, validation and certification methods, and terminology
- Access a big data pool for AV testing captured at the registered testbeds of IAMTS

To support the key aspects of the value proposition of IAMTS, the capabilities and operational performance criteria of registered testbeds will be documented in a database following a standardized evaluation format.

The Alliance will:

- Undertake activities and develop materials deemed necessary to meet the defined mission and vision
- Establish working groups to address topics
- Engage the expertise of external stakeholders as needed
- Share output / information with the global community
- Participate in specifications and standards activities

To bring together testbed users and testbed operators, IAMTS will negotiate discount rates of services for IAMTS members. Registered testbeds can leverage IAMTS to communicate their capabilities and attract users.

IAMTS will educate its members regularly about progress of smart mobility technologies with a focus on highly automated driving through training sessions and technology demonstration events at testbeds (which can also be combined with conference events where applicable).

IAMTS will carefully select the providers of membership services, define applicable registration and qualification processes and approvals, and define process for regular review and confirmation based on customer feedback and performance. Contact information of registered and approved service providers will be made available via a database to the members.

The proposed membership model of IAMTS:

IAMTS is made up of Member organizations which are engaged in the smart mobility ecosystem. To achieve its objectives, the Alliance has different levels of membership providing different levels of engagement and benefits. IAMTS offers memberships to both public and private, large and small organizations. The rationale behind this is to build a community of experts which can provide their knowledge and to build a community of corporations that can bring in both human and financial resources.

There are six membership levels as defined in the Membership Agreement: Expert, Affiliate, Base, Core, Strategic and Strategic Partner. The membership levels determine initial and annual membership fees, membership services eligibility and roles the member is allowed in the governance structure.

Membership Level based benefits are as described in the table below:

Membership Level	**Constraints & Opportunities**
Expert	Can be official service provider after registration and Committee approval.
Affiliate	Can be official service provider after registration and Committee approval.
Base	Can be official service provider after registration and Committee approval. Eligible for service discounts.
Core	Can be official service provider after registration and Committee approval. Eligible for service discounts. Eligible for committee and project leadership positions. Eligible for Technical Leadership Committee. One vote for general ballots and ballots to determine project and committee leadership.
Strategic	Can be official service provider after registration and Committee approval. Eligible for service discounts. Eligible for committee and project leadership positions. Eligible for Technical Leadership Committee. Eligible for Executive Committee. Two votes for general ballots and ballots to determine project and committee leadership.
Strategic Partner	Equivalent to Strategic Level.

See in **Addendum A** a matrix organization structure chart which provides a more detailed description of the membership categories and membership levels.

An important aspect of the membership model is to provide opportunities to members to become a service provider as well as to provide incentives to corporate members to utilize services through the Alliance. Below is an overview about the membership services that will be provided by IAMTS:

Membership Service	**Offering**
Training	• AV verification & validation methods • Mobility related rules & regulations
Consulting	• Design of smart mobility testbeds • Optimization of testbed operation • Development of AV test programs
Data Analytics	• Access to smart mobility testbed data base • Access to testbed big data pool • Specific data queries • User/Operator matchmaking
Testing	• Access to test facilities with specified capabilities at preferred conditions
Certification	• Access to auditors that can certify vehicles, infrastructure or testbeds
Projects	• Involvement in pre-competitive R&D projects through IAMTS partnerships
Conference and technology demonstration events	• Conference sponsoring • Customized technology demonstration events

The governance structure of IAMTS is composed of one board and two committees:

Overview of IAMTS Governance Structure	
Governing Body	**Purpose and Overview**
SAE ITC Board of Directors	Manages the business and affairs, and actively promotes the purposes, of ITC. Provides the legal framework, antitrust and intellectual property policies and insurance program.
Executive Committee	Decision-making body responsible for the leadership, management and financial obligations of the IAMTS, initially comprised of three Strategic Members or Partners. Develops, updates and approves membership charter; defines process for membership service providers; provides input to budget and contractors; approves appointments to Technical Leadership Committee; develops and approves strategic and operational goals; reviews revenue and budget development periodically; reviews operational performance of staff/contractors/service providers periodically
Technical Leadership Committee	Responsible for technical implementation of testbed data base, the testbed big data pool and the testbed certification program; responsible for R&D project partnerships; responsible for technical training program; responsible for technical program development of IAMTS conferences or conferences with IAMTS involvement; implements technical committees to support activities it is responsible for.

SAE ITC will provide the legal protections and policies to operate the Alliance. The support for the Alliance will be performed by the SAE ITC, but SAE ITC in its discretion can subcontract such support services to third parties.

SAE ITC will appoint SAE ITC staff to support the daily operations of the Alliance with input from the Executive Committee. The SAE ITC staff administratively reports to the SAE ITC Chief Operating Officer.

SAE ITC staff have no voting rights.

The Alliance SAE ITC staff is responsible for ongoing operational, technical and administration to support the Alliance, which include (but not limited to) the following;

- Serve as the single Point of Contact (POC) for the Alliance to ensure a direct line of communication with Members;
- Act as the Point of Contact (POC) and Spokesperson for communications with external organizations, such as media, press, government (NHTSA and others), prospective members, and other organizations, etc.;
- Act as the Point of Contact (POC) with SAE International;
- Evaluates, recommends and authorizes deployment and implementation of initiatives and work outputs/results of the Alliance;
- Establish MOUs, partnering agreements, contracts, etc.;
- Manage the Alliance's operational budget;
- Manage daily operations of the Alliance, e.g. marketing, branding, promotion, outreach/public relations, website, etc.;
- Hire staff, consultants, procure services to support Member approved tasks;
- Administrative support, such as accounting, procurement, space rental, utilities, IT services, marketing, communications, etc. may be contracted from SAE International, Thorn Hill LLC or other organizations at the discretion of the SAE ITC staff

A portion of IAMTS membership fees or other funds as applicable (e.g. grants, sponsorships and contributions) may be used for a smart mobility innovation fund which can co-finance pre-competitive research projects or innovation outreach events, leveraging either publicly or privately funded projects which include the utilization of smart mobility testbeds and contribute to the generation of test data.

See **Addendum B** for details of the IAMTS Organizational Roadmap.

See **Addendum C** for the IAMTS Activities Roadmap.

ADDENDUM A:
Membership Level Eligibility Matrix - IAMTS

	Membership Level					
	Strategic Partner	Strategic Member	Core Member	Basic Member	Affiliate Member	Expert
Regulation, Standards and Certification Providers	• SDO	• SDO • CTO	• SDO • CTO • Government	• SDO • CTO	• Government	
Testing Service Providers		• Test Facility • Operator • Simulator • RECS • ICT • Academic	• Test Facility • Operator • Simulator • RECS • ICT • Academic • Government	• Test Facility • Operator • Simulator • RECS • SmB*	• Academic • Government	• SmB*
Testing Service Consumers		• Manufacturer • Insurer • MaaS • RECS • ICT	• Manufacturer • Insurer • MaaS • RECS • ICT • Academic • Government	• MaaS • RECS • ICT • SmB	• Academic • Government	• SmB
Other		• Other**	• Other**	• Other**		

SDO =Standards Development Organization
CTO = Certification & Testing Organization
RECS = Research, Engineering and Consulting Services firm
ICT = Information and Communications Technology firm
MaaS = Mobility as a Service Provider
SmB = Small Business
Manufacturer = OEM or Tier 1-2 Supplier
Academic = Non-Profit Academic or Academic-Affiliated Research Institution
Operator = Testbed Operator or Test Operator
Government = Local, National, Regional and Regulatory
Other = Other organization whose products, services or interests are relevant to the IAMTS mission, vision and scope

*Must be certified by IAMTS
**Must have Executive Committee or Charter Member approval

ADDENDUM B:

IAMTS Organizational Roadmap

Phase 1 Q4 2018 - Q1 2019	Phase 2 Q2 2019 - Q4 2019	Phase 3 Q1 2020
•Approval of membership model and fee structure by sponsoring entities •Identification of and consultation with founding member candidates •Identification of strategic testbeds	•Commitment of founding members •Announcement of ISTMA at major conferences •Implementation of governance structure •Building of membership base and service portfolio	•Strategic review of implementation phase and membership feedback •Growth of membership portfolio •Optimization of membership service portfolio to ensure sustainable operation

ADDENDUM C:

IAMTS Activities Roadmap

1. Joint research activity: in-depth analysis of testing standards, certification systems and testbed operation methods with focus on ICV/CAV (intelligent connected vehicles, connected & automated vehicles) – first step emphasis on L3 Autonomy:
    - Testing certification systems for mass-produced L3 automated vehicles
    - Requirements of testing certification of testbeds for mass-produced L3 automated vehicles
2. Participate in the joint DIN-SAE series of specifications on testing of automated and connected vehicles
3. Establish a list of global testbeds and their unaudited capabilities
4. Create a pricing and discount sheet table for testing services to ISTMA Members
5. Create a database to house detailed information about global testbeds, operators and other service providers
6. Establish an auditing program for testbeds
7. Joint research activity: How to accelerate testing methods for vehicle-in-the-loop?
8. Joint research activity: What are the future smart mobility business models in North America, Europe and Asia-Pacific regions?