Consensus Safety Measurement Methodologies for ADS-Equipped Vehicles

June 25-26, 2019

SAE INTERNATIONAL

GLOBAL GROUND VEHICLE STANDARDS

Advanced Technology Standards Activities

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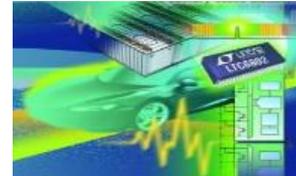**SAE INTERNATIONAL**

SAE Standards in Advanced Technology Focus Areas

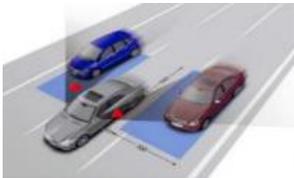
Wireless Charging

Driver-Vehicle Interface

Electronics System Reliability

Driving Automation Systems

Active Safety

Functional Safety

Connected Vehicles

Shared Mobility

EV/Hybrid/FC Vehicle & Battery

Vehicle Electronics Cyber Security

Intelligent Transport Systems

Mobility for Elderly and Persons with Disabilities

SAE ADAS Vehicle Standards Activities

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┌─────────────────┐
│  Active Safety  │
│     Systems     │
│    Standards    │
│    Committee    │
└─────────────────┘
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- **Active Safety Test Target Validation Correlation Task force**
- **Active Safety Bicycle Test Targets Task Force**
- **Vehicle Lane Deviation Warning Task Force**
- **Hardware-in-the-Loop Task Force**
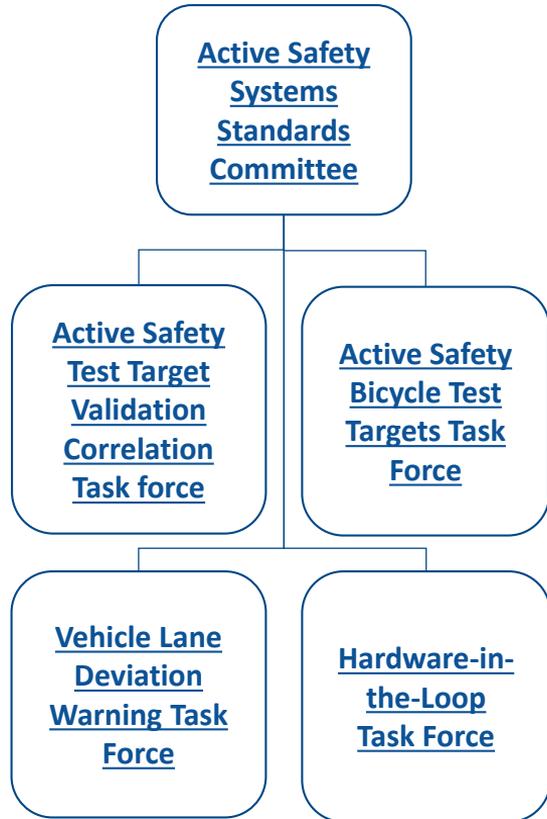
Standards focus has shifted from Passive Safety to collision mitigation:

- ✓ Electronic Stability Control
- ✓ Traction Control
- ✓ Adaptive Cruise Control
- ✓ Forward Collision Warning
- ✓ Rear Collision Warning
- ✓ Lane Departure Warning
- ✓ Crash Imminent Braking
- ✓ Blind Spot Detection
- ✓ Adaptive Headlamps

SAE Automated Vehicle Standards Activities

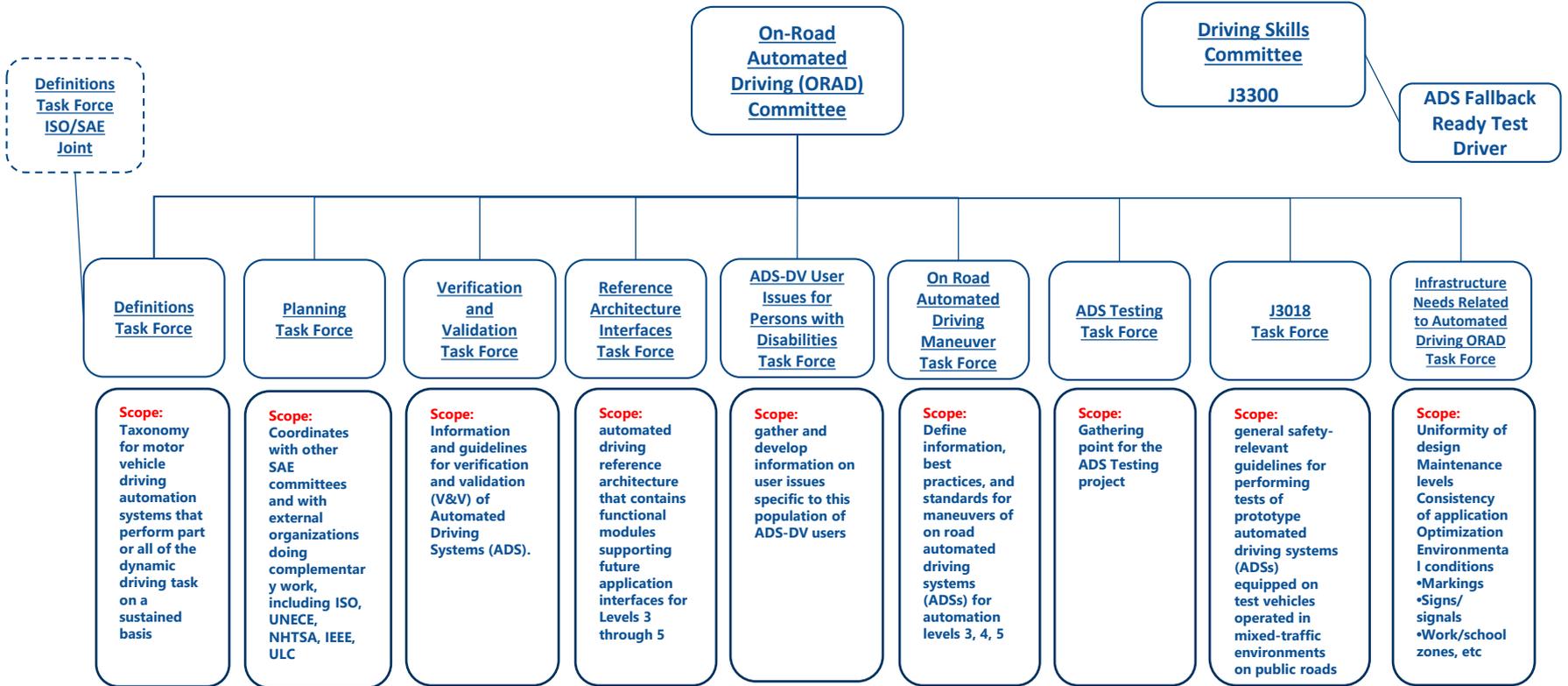**On-Road Automated Driving (ORAD) Committee**

Driving Skills Committee

J3300

ADS Fallback Ready Test Driver

Definitions Task Force ISO/SAE Joint

Definitions Task Force	**Planning Task Force**	**Verification and Validation Task Force**	**Reference Architecture Interfaces Task Force**	**ADS-DV User Issues for Persons with Disabilities Task Force**	**On Road Automated Driving Maneuver Task Force**	**ADS Testing Task Force**	**J3018 Task Force**	**Infrastructure Needs Related to Automated Driving ORAD Task Force**
Scope: Taxonomy for motor vehicle driving automation systems that perform part or all of the dynamic driving task on a sustained basis	**Scope:** Coordinates with other SAE committees and with external organizations doing complementary work, including ISO, UNECE, NHTSA, IEEE, ULC	**Scope:** Information and guidelines for verification and validation (V&V) of Automated Driving Systems (ADS).	**Scope:** automated driving reference architecture that contains functional modules supporting future application interfaces for Levels 3 through 5	**Scope:** gather and develop information on user issues specific to this population of ADS-DV users	**Scope:** Define information, best practices, and standards for maneuvers of on road automated driving systems (ADSs) for automation levels 3, 4, 5	**Scope:** Gathering point for the ADS Testing project	**Scope:** general safety-relevant guidelines for performing tests of prototype automated driving systems (ADSs) equipped on test vehicles operated in mixed-traffic environments on public roads	**Scope:** Uniformity of design Maintenance levels Consistency of application Optimization Environmental conditions •Markings •Signs/ signals •Work/school zones, etc

ORAD Committee Standards Overview

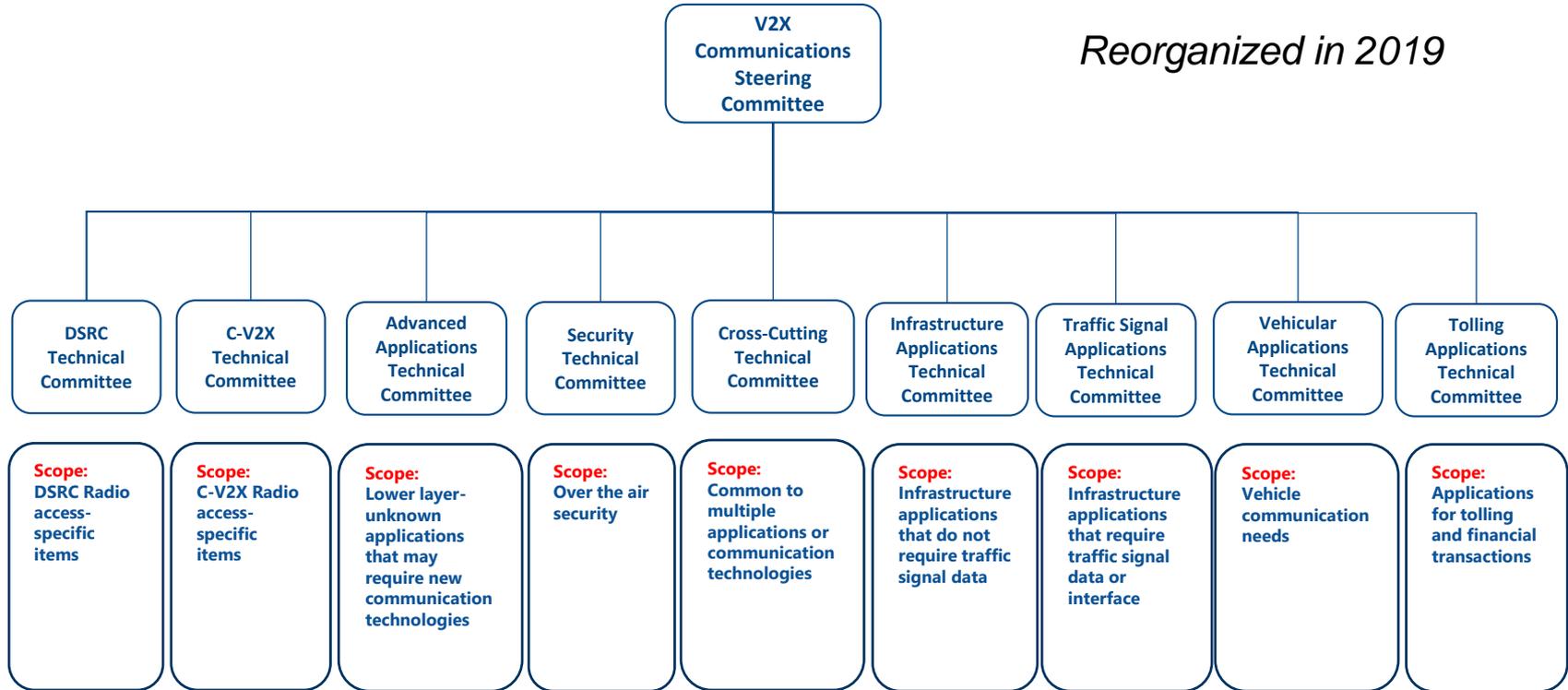| Standard	Description	Status / Timing
J3016™	Recommended Practice: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles Seminal standard for automated driving systems (ADS) that defines key terms and a hierarchy of automation (levels 0-5). Allows industry to speak with a common language about ADS.	Originally published as an information report in 2014. Current Recommended Practice was published in September 2016. A revision was published by June 2018. Associated 1-page infographic expected to be issued soon. Currently being revised jointly with ISO TC204 WG14 to further clarify and refine definitions and specifically deepen the Operational Design Domain (ODD) definition. May be published by end of 2019.
J3018™	Information Report: Guidelines for Safe On-Road Testing of SAE Level 3, 4, and 5 Prototype Automated Driving Systems (ADS) This document provides guidelines for the safe conduct of on-road tests of vehicles equipped with prototype conditional, high, and full (levels 3-5) automated driving systems (ADSs), as defined by SAE J3016.	Originally Published March 2015. Revision is in balloting now. The standard was re-opened in April 2018. Updating contents by incorporating lessons-learned and making it compatible with related standards. Expected publication in 2019.
J3131™	Recommended Practice: Automated Driving Reference Architecture Defines an ADS reference architecture that contains functional modules supporting future application interfaces for Levels 3 through 5 (J3016) with supporting terminology and best practices.	Balloting. The first document, J3131/1 expected publication in 2019. ORAD experts anticipate follow-on document parts.

ORAD Committee Standards Overview

Standard	Description	Status / Timing
J3092™	Information Report: Dynamic Test Procedures for Verification and Validation of Automated Driving Systems	In development. Completing literature review of activities for more than 20 entities across the world working on automated vehicles. Task Force intends for an eventual V&V Recommended Practice, but is currently is pursuing an Information Report.
J3171™	Information Report: ADS-DV User Issues for Persons with Disabilities It is expected that level 4 and 5 Automated Driving System - dedicated vehicles (ADS-DVs) will eventually enable persons to travel at will who are otherwise unable to obtain a driver's license for a conventional vehicle, namely, persons with visual, physical, and/or cognitive impairments.	In development. The information report is being developed through literature review (including regulatory requirements, research papers and policy statements) and interviews with advocacy groups, government agencies, and researchers. Publication timing not yet finalized, but potentially by mid-2019.
J3164™	Taxonomy and Definitions for Terms Related to Automated Driving System Behaviors and Maneuvers for On-Road Motor Vehicles Focused on behaviors and maneuvers for ADS for automation levels 3 through 5.	In development. Begun in January 2018. The task force will seek to codify the behaviors and maneuvers for ADS levels 3-5. Reviewing NHTSA documents regarding human drivers and research from California PATH and University of Waterloo. ORAD Committee feels that Variable Performance Testing for ADS activities outside of the SAE standards committee structure will feed this task force to develop more robust SAE standards. Likely stemming from a common approach to developing testing scenarios will arise.

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Additional Committee Activity for Developing Automation Standards

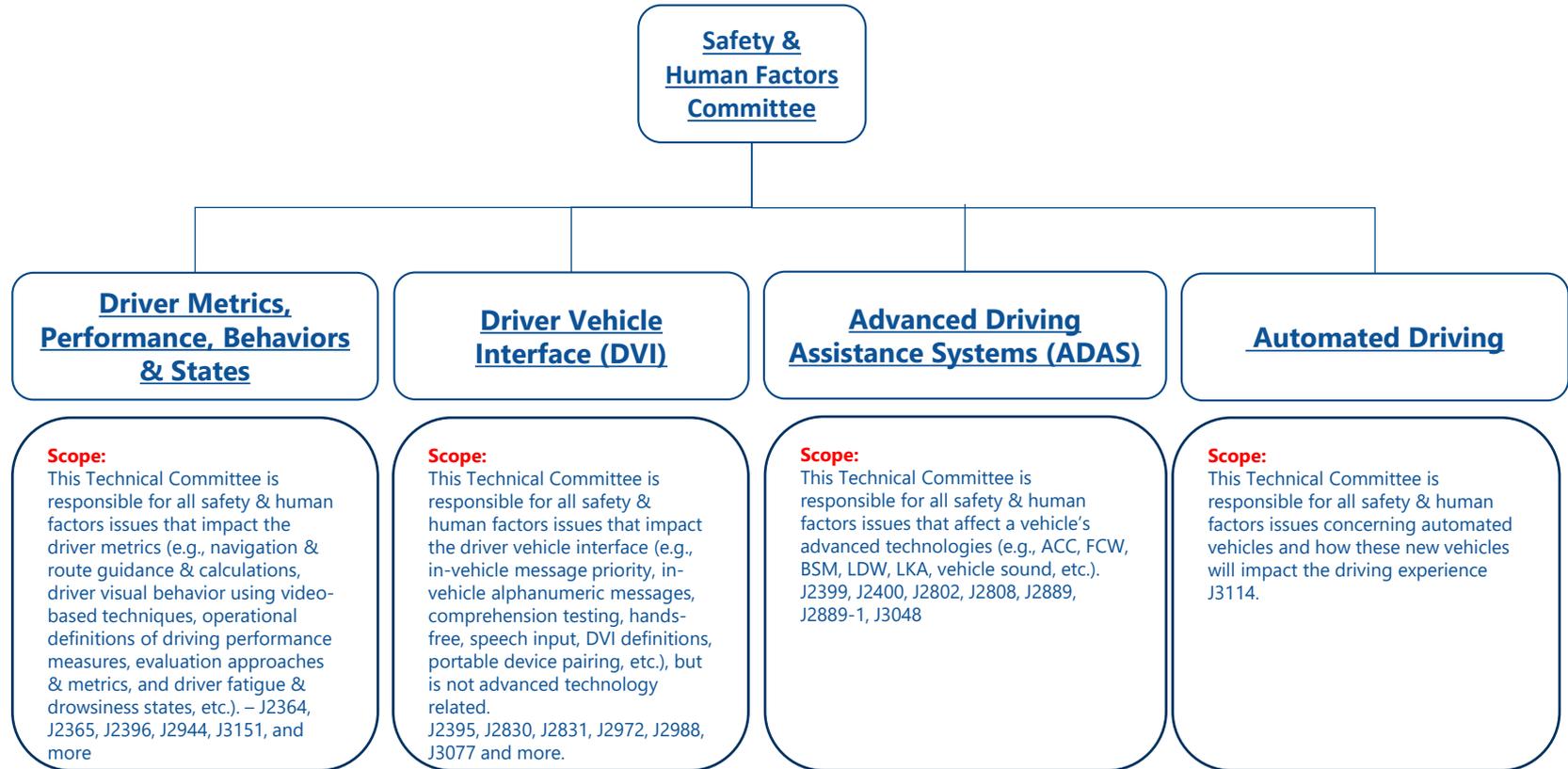| Committee	Overview
Driving Automation Systems	This Technical Committee is responsible for all safety & human factors issues concerning driving automation systems and how these new technologies will impact the driving experience. This includes any vehicle that involves human operation, either in-vehicle or remotely located, transitioning into or out of Level 1 driving automation and above, and/or based on any interaction of human road users with driving automation systems. J3114- Human Factors Definitions for Automated Driving and Related Research Topics (Dec 2016)
ADS Logger Task Force	The Event Data Recorder Committee established this Task Force to detail ADS data elements and definitions that can be gathered in crash or near-crash events in ADS. These additional data elements may be those useful for accident reconstruction involving an ADS-equipped vehicle or allowing determination of whether further analysis into the ADS system performance or non-ADS system performance is needed.
ADS Lamps Task Force	Signaling and Marking Devices Standards Committee established this Task Force to develop test procedures, performance requirements, and design guidelines for autonomous vehicle lighting (J3134).
Driving Skills Committee	Drafting J3300 AV Safety Operator endorsement for test drivers (safety operators) on proving grounds as a complement to the four skill levels defined in the foundational license.

V2X Communications Standards Activities

Reorganized in 2019

V2X Communications Steering Committee

DSRC Technical Committee	C-V2X Technical Committee	Advanced Applications Technical Committee	Security Technical Committee	Cross-Cutting Technical Committee	Infrastructure Applications Technical Committee	Traffic Signal Applications Technical Committee	Vehicular Applications Technical Committee	Tolling Applications Technical Committee
Scope: DSRC Radio access-specific items	**Scope:** C-V2X Radio access-specific items	**Scope:** Lower layer-unknown applications that may require new communication technologies	**Scope:** Over the air security	**Scope:** Common to multiple applications or communication technologies	**Scope:** Infrastructure applications that do not require traffic signal data	**Scope:** Infrastructure applications that require traffic signal data or interface	**Scope:** Vehicle communication needs	**Scope:** Applications for tolling and financial transactions

SAE Human Factors Standards Activities

Safety & Human Factors Committee

Driver Metrics, Performance, Behaviors & States

Scope:
This Technical Committee is responsible for all safety & human factors issues that impact the driver metrics (e.g., navigation & route guidance & calculations, driver visual behavior using video-based techniques, operational definitions of driving performance measures, evaluation approaches & metrics, and driver fatigue & drowsiness states, etc.). – J2364, J2365, J2396, J2944, J3151, and more

Driver Vehicle Interface (DVI)

Scope:
This Technical Committee is responsible for all safety & human factors issues that impact the driver vehicle interface (e.g., in-vehicle message priority, in-vehicle alphanumeric messages, comprehension testing, hands-free, speech input, DVI definitions, portable device pairing, etc.), but is not advanced technology related.
J2395, J2830, J2831, J2972, J2988, J3077 and more.

Advanced Driving Assistance Systems (ADAS)

Scope:
This Technical Committee is responsible for all safety & human factors issues that affect a vehicle's advanced technologies (e.g., ACC, FCW, BSM, LDW, LKA, vehicle sound, etc.). J2399, J2400, J2802, J2808, J2889, J2889-1, J3048

Automated Driving

Scope:
This Technical Committee is responsible for all safety & human factors issues concerning automated vehicles and how these new vehicles will impact the driving experience J3114.

Other SAE AV-Related Standards Activities

Cyber Security

SAE Vehicle Electrical System Security Committee

- Vehicle Electrical Hardware Security Task Force
- RFC Cybersecurity Task Force

SAE Vehicle Cybersecurity Systems Engineering Committee

- Cybersecurity Assurance Testing Task Force
- Automotive Cybersecurity Integrity Level (ACsIL) Task Force

J3061 Cyber Security Guidebook

Shared & Digital Mobility

Committee established 2017

- J3163 – Taxonomy and Definitions for Terms Related to Shared Mobility and Enabling Technologies

TRAVEL MODES	MOBILITY APPLICATIONS	SERVICE MODELS	OPERATIONAL MODELS	BUSINESS MODELS	DEPRECATED TERMS
Bikesharing & Carsharing	Mobility Tracker Apps	P2P Service Model	Station-Based Round Trip	B2B & B2C Services	Ridesharing

Next steps:

- Symbols and signage for shared mobility
- Data format for data sharing
- Household travel surveys

Micromobility

Committee established 2018

- Focus on low-speed personal mobility devices, technology, and systems
- Not normally subject to the United States FMVSS or similar regulations

Initial tasks:

- Taxonomy of Micromobility Devices
- Take up ORAD J3171 ADS-DV User Issues for Persons with Disabilities

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Automated Vehicle Safety Consortium™

A Program of SAE ITC

- **Vision:** Public acceptance of SAE L4/L5 automated driving systems as a safe and beneficial component of transportation through industry consensus.

- **Mission:** The mission of the Automated Vehicle Safety Consortium is to **quickly** establish safety principles, common terminology, and best safety practices, **leading to standards** to **engender public confidence** in the safe operation of SAE L4/L5 light duty passenger/cargo on-road vehicles ahead of their widespread deployment.

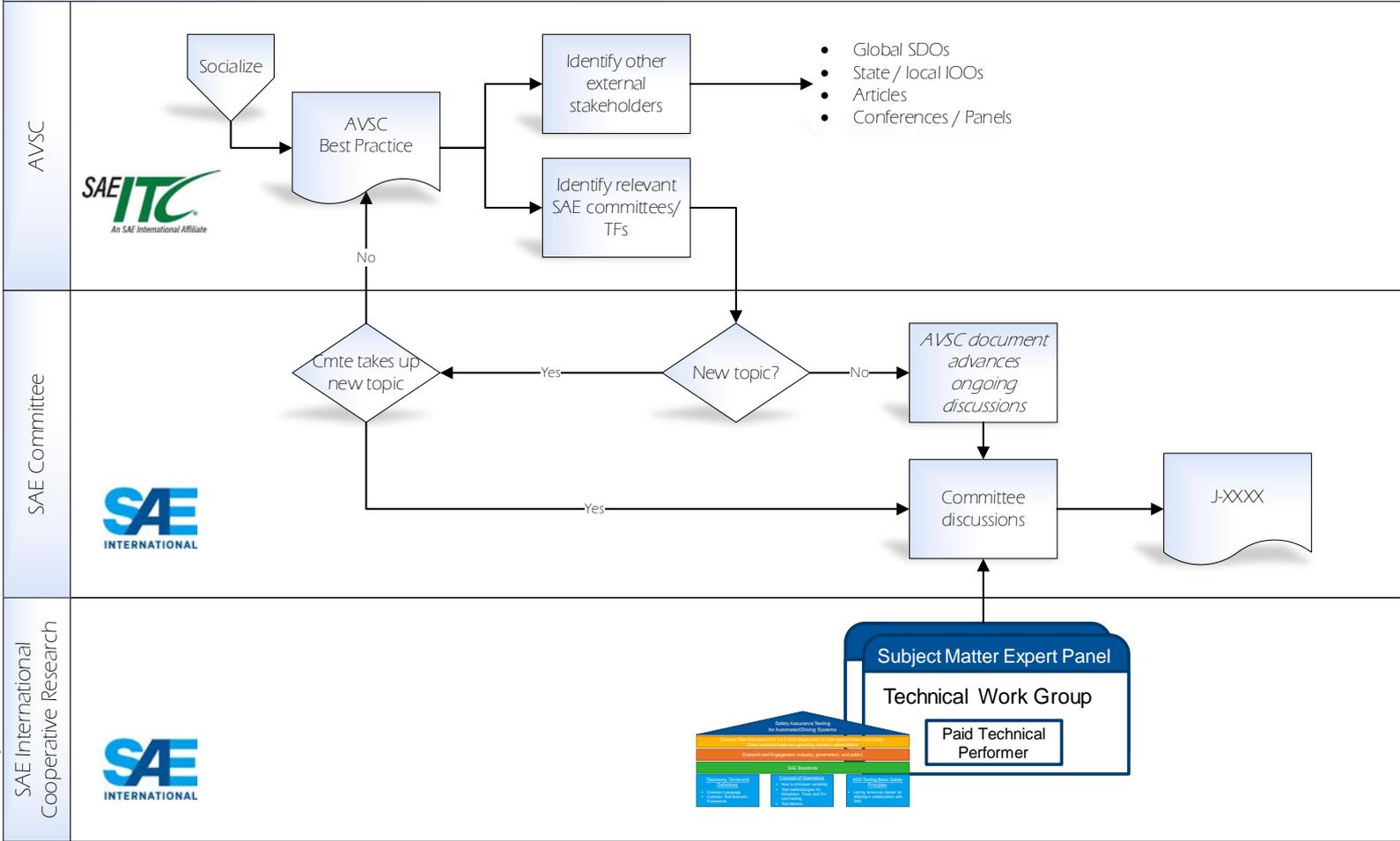# Automated Vehicle Safety Consortium™

A Program of SAE ITC

- Prioritized safety principles

- Identify and agree upon key considerations for the deployment of AVs on public roads

- Technology neutral

- Initial themes:

  1. Testing: Before deploying vehicles on public roads, there are testing processes and human aspects to be considered.   VSSAs are a good start, but we believe there is a greater level of detail in certain areas that companies can provide in a common way that can engender public confidence and raise the bar for transparency.

  2. Interaction: AVs will interact with humans on board the vehicle as well as other road users when they participate in the transportation system. Consistency will help humans be better prepared to interact with AVs.

  3. Data: AVs require data to understand their surroundings and humans require data to feel confident AVs are deployed in situations where they can improve safety and the efficient movement of goods and people. The expectation for AVs is they will improve the safety of our roads, but for many reasons, crashes are inevitable. Thoughtful and consistent collection, protection and sharing scene and vehicle data will be critical to maximizing the learning potential from these crashes.

Automated Vehicle Safety Consortium (AVSC)

Relationship with Open Standards

AVSC

Socialize

AVSC Best Practice

SAE ITC
An SAE International Affiliate

Identify other external stakeholders

- Global SDOs
- State / local IOOs
- Articles
- Conferences / Panels

Identify relevant SAE committees/ TFs

No

SAE Committee

Cmte takes up new topic

Yes

New topic?

No

AVSC document advances ongoing discussions

Yes

Committee discussions

J-XXXX

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SAE International Cooperative Research

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Subject Matter Expert Panel

Technical Work Group

Paid Technical Performer

Safety Assurance Testing for Automated Driving Systems

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