Development of Industry Standards to support Advanced Driver Assistance Systems, Connected Vehicle and Automated Driving Technologies

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Our Portfolio

PUBLICATIONS
100,000+ collection of technical publications

CONFERENCES
30+ technical conferences worldwide

TECHNICAL STANDARDS
35,000+ aerospace and ground vehicle standards

MEDIA
Magazines, eNewsletters, Tech Briefs

MEMBERSHIP
145,000+ members worldwide

FOUNDATION
SAE’s charitable arm supporting STEM

PROFESSIONAL DEVELOPMENT
Extensive portfolio of courses, webinars
SAE Global Ground Vehicle Standards in a Nutshell

- 8,375 Standards Published
- 1,817 Standards Maintained
- 491 WIP Standards

9,933 Committee Members
609 Technical Committees
2,898 Companies
SAE Standards Ballot Process
GV SAE standards cited in U.S. regulations

- NHTSA: 232
- EPA: 87
- DOL/MSHA: 42
- DOL/OSHA: 40
- DHS/USCG: 24
- DOT/FMCSA: 21
- HUD/HC: 3
- DOT/FAA: 2
- FTC: 1
- CPSC: 1
Regulatory and Product Effect of SAE Standards

SAE Standards

Product Development

1 country 1 vote

1 expert 1 vote

BMW, Daimler, Audi, VW, Continental, Bosch

FCA, Ford, GM, Aptiv, Magna, Delphi

Honda, Nissan, Toyota, Denso

World Regs

Germany

Sweden

Italy

France

UK

Japan

China

S.Korea

SAE

ISO

IEC

UNECE

SAE

NHTSA

EPA
Define operating design domains for testing

• “Variable” performance testing.
• AV crash data and testing scenarios
• Simulation and physical testing

“Cooperative automation” (FHWA)

SAE Government / Industry meeting: 3-5 April (https://www.sae.org/attend/government-industry)
Key Focus Areas for Standards

- **TERMS & DEFINITIONS**: J3016 & J3063
- **SECURITY**: J3061 & J3101
- **SAFETY**: J1626/2 & J3092
- **INTEROPERABILITY**: J2735 & J2953
- **VEHICLE SYSTEM & PERFORMANCE REQUIREMENTS**: J2945/1 & J3155
- **GUIDELINES & RECOMMENDED PRACTICES**: J3018 & J3088
- **TEST & VERIFICATION METHODS**: J3045 & J3029
Where SAE automated vehicle standards are developed

- **Definitions Task Force (ISO/SAE Joint)**
  - **Scope:** Taxonomy for motor vehicle driving automation systems that perform part or all of the dynamic driving task on a sustained basis

- **Planning Task Force**
  - **Scope:** Coordinates with other SAE committees and with external organizations doing complementary work, including ISO, UNECE, NHTSA, IEEE, ULC

- **Verification and Validation Task Force**
  - **Scope:** Information and guidelines for verification and validation (V&V) of Automated Driving Systems (ADS)

- **Reference Architecture Interfaces Task Force**
  - **Scope:** Automated driving reference architecture that contains functional modules supporting future application interfaces for Levels 3 through 5

- **ADS-DV User Issues for Persons with Disabilities Task Force**
  - **Scope:** Gather and develop information on user issues specific to this population of ADS-DV users

- **On Road Automated Driving Maneuver Task Force**
  - **Scope:** Define information, best practices, and standards for maneuvers of on road automated driving systems (ADSS) for automation levels 3, 4, 5

- **ADS Testing Task Force**
  - **Scope:** Gathering point for the ADS Testing project

- **Driving Skills Committee J3018 Task Force**
  - **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

- **Driving Skills Committee J3300**
  - **Scope:** Uniformity of design
    - Maintenance levels
    - Consistency of application
    - Optimization
    - Environmental conditions
      - Markings
      - Signs/signals
      - Work/school zones, etc.

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

- **Infrastructure Needs Related to Automated Driving ORAD Task Force**
  - **Scope:** Endorsement to the foundational license

- **ADS Fallback Ready Test Driver**
  - **Scope:** Information and guidelines for verification and validation (V&V) of Automated Driving Systems (ADS).
<table>
<thead>
<tr>
<th>Level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>DDT</th>
<th>OEDR</th>
<th>DDT Fallback</th>
<th>ODD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Driving Automation</td>
<td>The performance by the driver of the entire DDT, even when enhanced by active safety systems</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>The sustained and ODD-specific execution by a driving automation system of either the lateral or the longitudinal vehicle motion control subtask of the DDT (but not both simultaneously) with the expectation that the driver performs the remainder of the DDT.</td>
<td>Driver and System</td>
<td>Driver</td>
<td>Driver</td>
<td>Limited</td>
</tr>
<tr>
<td>2</td>
<td>Partial Driving Automation</td>
<td>The sustained and ODD-specific execution by a driving automation system of both the lateral (and longitudinal) vehicle motion control subtasks of the DDT with the expectation that the driver completes the OEDR subtask and supervises the driving automation system.</td>
<td>System</td>
<td>Driver</td>
<td>Driver</td>
<td>Limited</td>
</tr>
<tr>
<td></td>
<td><strong>ADS (&quot;System&quot;) performs the entire DDT (while engaged)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Conditional Driving Automation</td>
<td>The sustained and ODD-specific performance by an ADS of the entire DDT with the expectation that the DDT failback-ready user is receptive to ADS-issued requests to intervene, as well as to DDT performance-relevant system failures in other vehicle systems, and will respond appropriately.</td>
<td>System</td>
<td>System</td>
<td>Fallback-ready user (becomes the driver during failback)</td>
<td>Limited</td>
</tr>
<tr>
<td>4</td>
<td>High Driving Automation</td>
<td>The sustained and ODD-specific performance by an ADS of the entire DDT and DDT failback without any expectation that a user will respond to a request to intervene.</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>Limited</td>
</tr>
<tr>
<td>5</td>
<td>Full Driving Automation</td>
<td>The sustained and unconditional (i.e., not ODD-specific) performance by an ADS of the entire DDT and DDT failback without any expectation that a user will respond to a request to intervene.</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>
SAE ORAD Infrastructure Task Force (new)
SAE DSRC Technical Committee (TC) Responsibility & Structure

• Scope: Develop and maintain V2X message set and application standards/recommended practices for interoperability, with short- to medium-range wireless communication protocols

• Concentration of experts group in various Task Forces (approx. 60 members)

• Coordinates with other organizations involved in V2X effort such as related SAE TCs, ETSI, ISO, 5GAA, 3GPP. Activities include maintaining common data dictionary items, organizing initial effort of gathering use cases, defining work boundaries, etc.
SAE DSRC Technical Committee Documents

- Supports interoperability
- Defines standardized message sets
- Defines formats for basic safety message set dictionary
- Being revised to meet new needs/applications

J2735 Message Set Dictionary
- Basic Safety Message (BSM)
- MapData (Map) message
- Signal Phase and Timing (SPaT)
- Personal Safety Message (for pedestrian and other vulnerable road users)
- Traveler Information Message (TIM)

- System engineering example
- Communication protocol
- Channel use
- V2X message/application priority
- ...

J2945/1 On-Board System Requirements for V2V Safety Communications
J2945/9 VRU (V2P) Safety Message Minimum Performance Requirements
J2945/2 Performance Requirements for V2V Safety Awareness
J2945/3 Weather Applications
J2945/4 V2I Road Safety
J2945/5 V2X Security
J2945/6 CACC/Platooning
J2945/7 Positional Improvements
J2945/8 Cooperative Perception
J2945/10 Map/SPaT Related
J2945/11 Signal Preemption
J2945/12 Probe Data
J2945/X Toll Collection
SAE Shared and Digital Mobility Committee embarked on the task of standardizing terms and definitions related to shared mobility.

**MILESTONES**
- Established in September 2017
- First technical report: J3163 – Taxonomy and Definitions for Terms Related to Shared Mobility and Enabling Technologies.

It covers six categories of terms related to shared mobility:

- Symbols and signage for shared mobility
- Data format for data sharing
- Household travel surveys
- Exploring intersect with core GV technologies
Emerging and innovative mobility vehicles and devices, sometimes referred to as micro-mobility, are proliferating in cities around the world.

These technologies have the potential to expand mobility options for a variety of people. Some of these technologies fall outside traditional definitions, standards, and regulations.

This committee will initially focus on low-speed personal mobility devices and the technology and systems that support them that are not normally subject to the United States Federal Motor Vehicle Safety Standards or similar regulations. These may be device-propelled or have propulsion assistance.
SAE Cyber Security Standards Activities

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

...but isn’t technology moving too fast?
Identifying new paradigms in assessment, testing and validation of connected and automated vehicles

Partnership with SAE Journal of Automated and Connected Vehicles
- Editor-in-chief, Venkat Krovi, Michelin Endowed Chair Professor of Vehicle Automation at CU-ICAR

SAE Authored Papers – new SAE Edge Research Report
- Based on submitted Symposium SME discussion papers, presentations and dialogue
  1. Automated Vehicle Deployment Safety
  2. Uncontrolled Environment AV Testing
  3. Controlled Environment AV Testing
  4. Simulated Environment AV Testing
  5. Automated Vehicle Testing Ontology
  6. Automated Vehicle Testing Data Opportunities
Connected and Automated Vehicles: An SAE International Journal furthers the state of the art of engineering research by promoting high-quality theoretical and applied investigations in the arena of connected and autonomous vehicles (CAVs) in on-road, off-road, and aerial operational environments. The enormous growth in numbers, diversity, and complexity of CAVs has been driven by:

- enhancements of fundamental scientific understanding;
- technological convergence of computing, communication, and miniaturization; and
- increased scale and complexity of tangible embodiments and engineering implementations at the component-, subsystem-, and system-levels.
June 28 Launch Subject Matter Expert Workshop

- Facilitated by Sven Beiker, Silicon Valley-based consultant
  - Former Executive Director, CARS
  - Former Senior Manager, BMW

Contributions from 18 industry sensor experts

Topics identified

- Taxonomy for Sensor Data Layers
- Testing, Simulation, Calibration of Sensors
- Security, Robustness, Integrity of Sensors
- Outlook, Date Security and Privacy

Participating Organizations:
- NXP Semiconductors
- BMW
- Continental
- Daimler
- Exponent
- Hyundai
- Luminar
- Motus Ventures
- Multek
- NVIDIA
- Ouster
- Peloton
- Toyota Research
- Velodyne
SAE AutoDrive Challenge – Preparing the next generation of engineers

1. Build formal **workforce development** connections between industry and academia.

2. Establish an integrated standards-based educational program that requires component integration and software development to enable J3016 (level 4) automated operation.

3. Provide the latest resources, equipment and training needed to accelerate development.

4. Have some fun along the way.
Public Awareness - SAE Demo Days and Connect2Car

• Educates the public through direct interaction and participation with automated vehicle demonstrations around the United States.

• For the inaugural SAE Demo Day in Tampa, FL, participants traveled on a public freeway in a fully-autonomous (SAE Level 4) vehicle developed by Perrone Robotics. (SAE)
SAE Standards

**SAE Ground Vehicle Standards (J Reports)** ........ 2,100+
**SAE Aerospace Material Specifications (AMS)** .... 2,700+
**SAE Aerospace Standards (AS)** ......................... 4,900+
**SAE Historical Standards** .................................. 35,000+

Over 207,000 Publications

| SAE eBooks | 400+ |
| SAE Technical Papers | 100,000+ |
| SAE eMagazines | 9,000+ |

SAE Journals

**Aerospace, Alternative Powertrains; Commercial Vehicles; Connected and Automated Vehicles, Engines; Fuels and Lubricants, Materials and Manufacturing; Passenger Cars – Electronic and Electrical Systems, Passenger Cars – Mechanical Systems; Transportation Safety; Transportation Cybersecurity and Privacy; Vehicle Dynamics, Stability, and NVH**

https://saemobilus.sae.org/
Developing a pre-competitive, industry-wide approach to variable performance testing (VPT) for ADS safety assurance that ensures public confidence.

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