SAE INTERNATIONAL

CONNECTIVITY, DRIVER ASSISTANCE AND AUTOMATED DRIVING OVERVIEW

Standards Development: Enabling Technologies, Trends, & Transition

FMCSA - Motor Safety Advisory Committee

Bill Gouse
Director, Federal Program Development
202.281.5844 / S.William.Gouse@sae.org

Motivation

- Safety
- Productivity
- Environment
- Competitiveness
- Security
- Convenience
- Satisfaction
- …

SAE Portfolio

PUBLICATIONS
100,000+ collection of technical publications

CONFERENCES
30+ Technical Conferences worldwide w/20,000+ attendees

TECHNICAL STANDARDS
35,000+ aerospace and ground vehicle standards

MEDIA
Magazines, *e*Newsletters, custom publishing, Tech Briefs Media Group

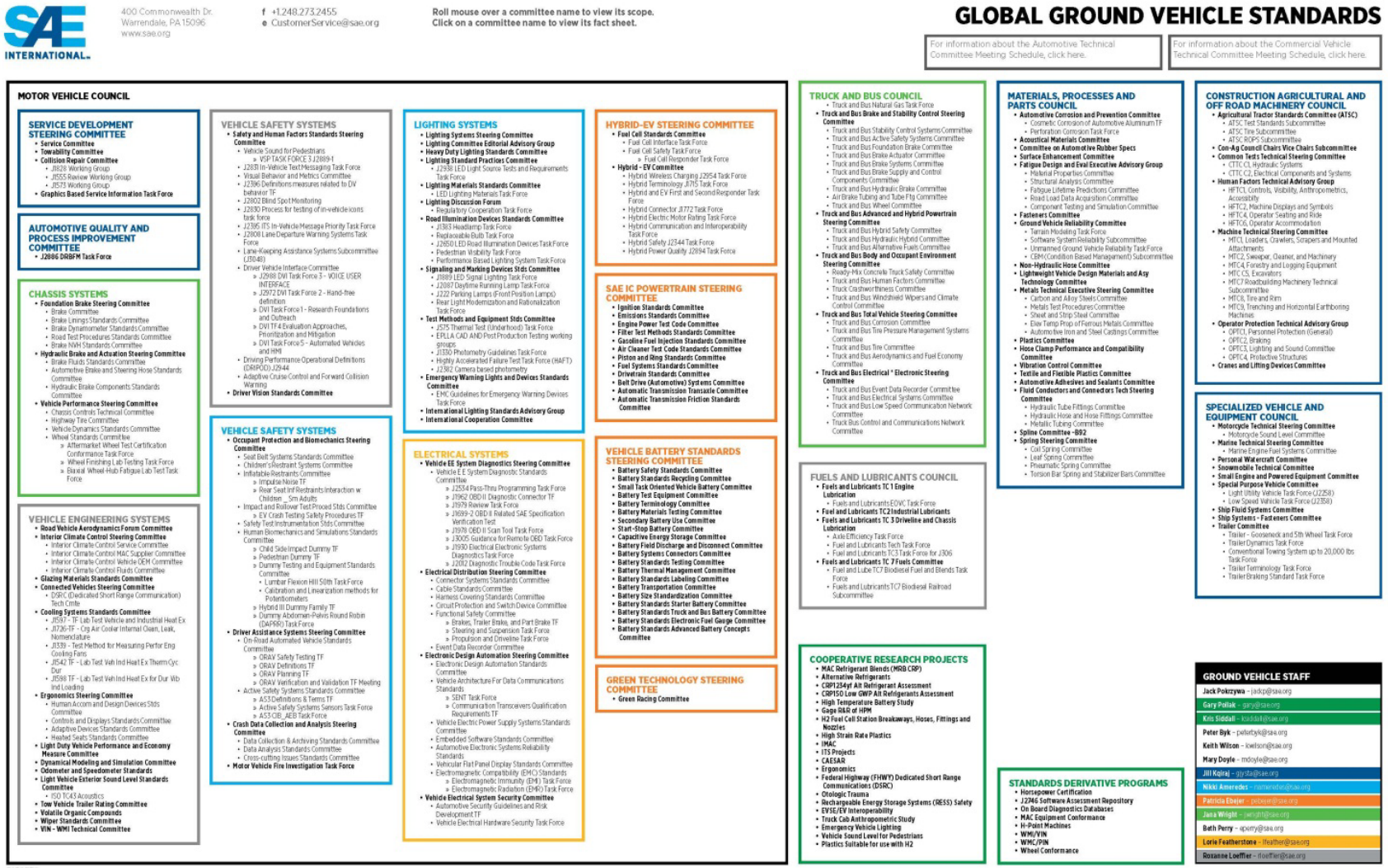
MEMBERSHIP
145,000 members worldwide, multiple-tiered/benefit model

MEDIA
Magazines, *e*Newsletters, custom publishing, Tech Briefs Media Group

FOUNDATION
Charitable arm of SAE International, supporting STEM for over 30 years

PROFESSIONAL DEVELOPMENT
400 courses portfolio, webinars; in-house, corporate and self-paced learning

SAE Standards Development



528 committees

8,900 members

2,900 companies

1,500 meetings

2015 standards

Issued = 36

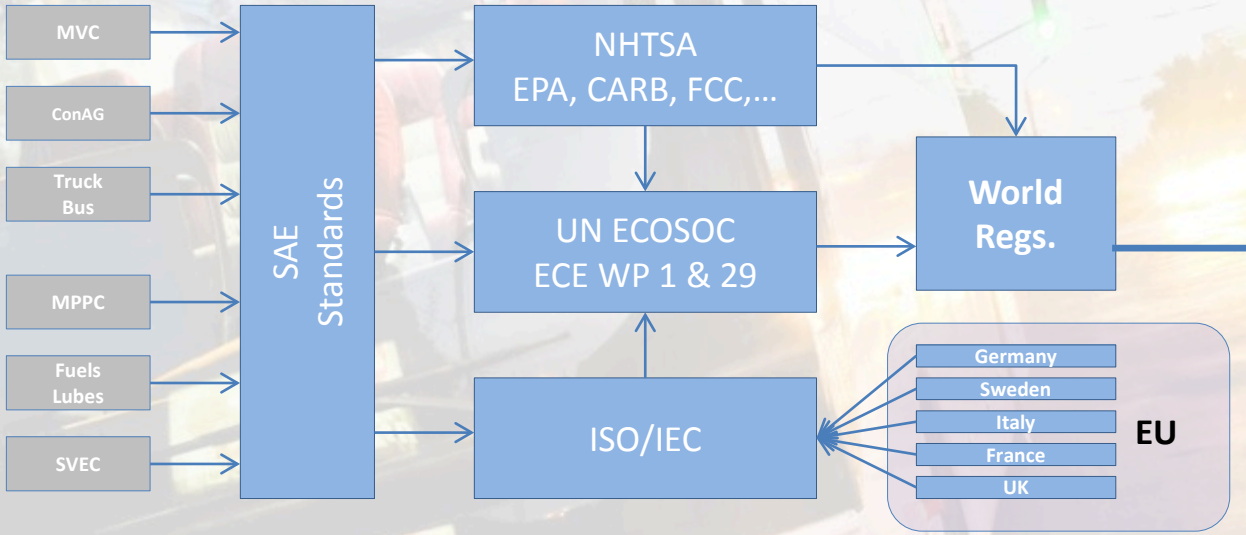
Revised = 123

Reaffirmed = 30

Stabilized = 31

Cancelled = 16

FROM SAE STANDARD TO REGULATION TO PRODUCT COMPLIANCE

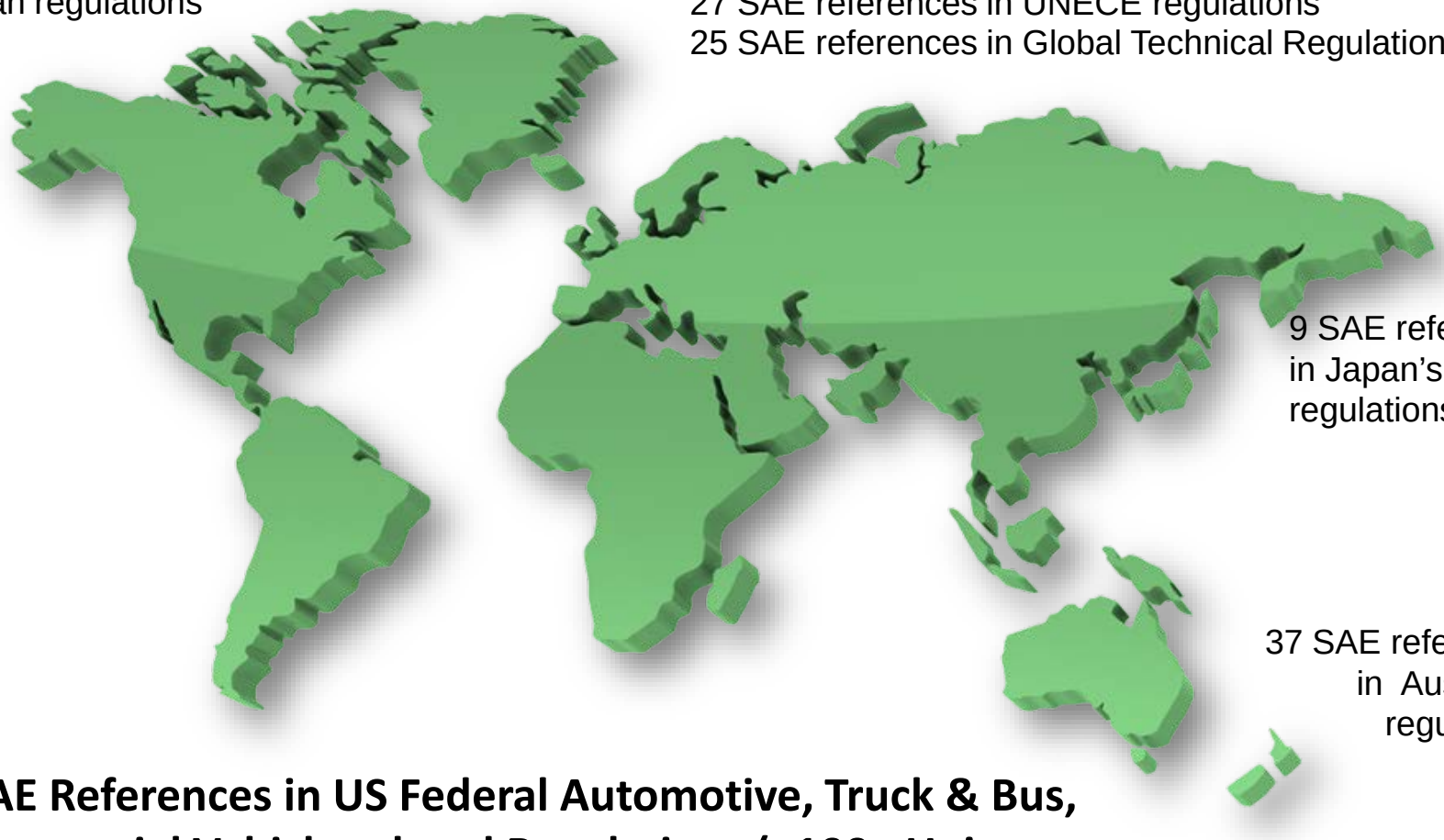


Product Development

SAE's Global Influence: SAE standards meet all six WTO principles for international standards & NTTA 1996/ OMB Circular A-119

40 SAE references in Canadian regulations

78 SAE references in ISO regulations
27 SAE references in UNECE regulations
25 SAE references in Global Technical Regulations



9 SAE references in Japan's regulations

37 SAE references in Australian regulations

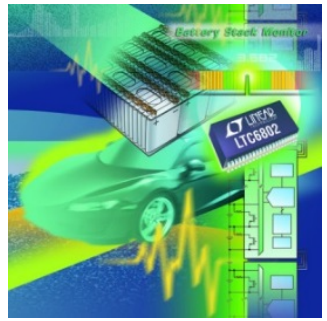
350+ SAE References in US Federal Automotive, Truck & Bus, and Commercial Vehicle related Regulations (~100+ Unique Standards). SAE standards referenced in states and territories.

New Technology in SAE Committees

Wireless Charging

Driver Distraction (Driver-Vehicle Interface)

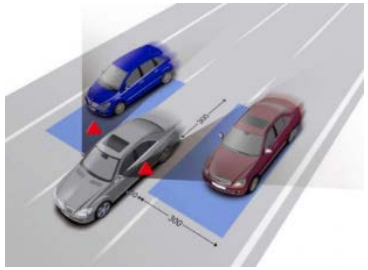
Automotive Electronics System Reliability



Automated Driving Systems

Functional Safety

EV/Hybrid/FC Vehicle &Battery

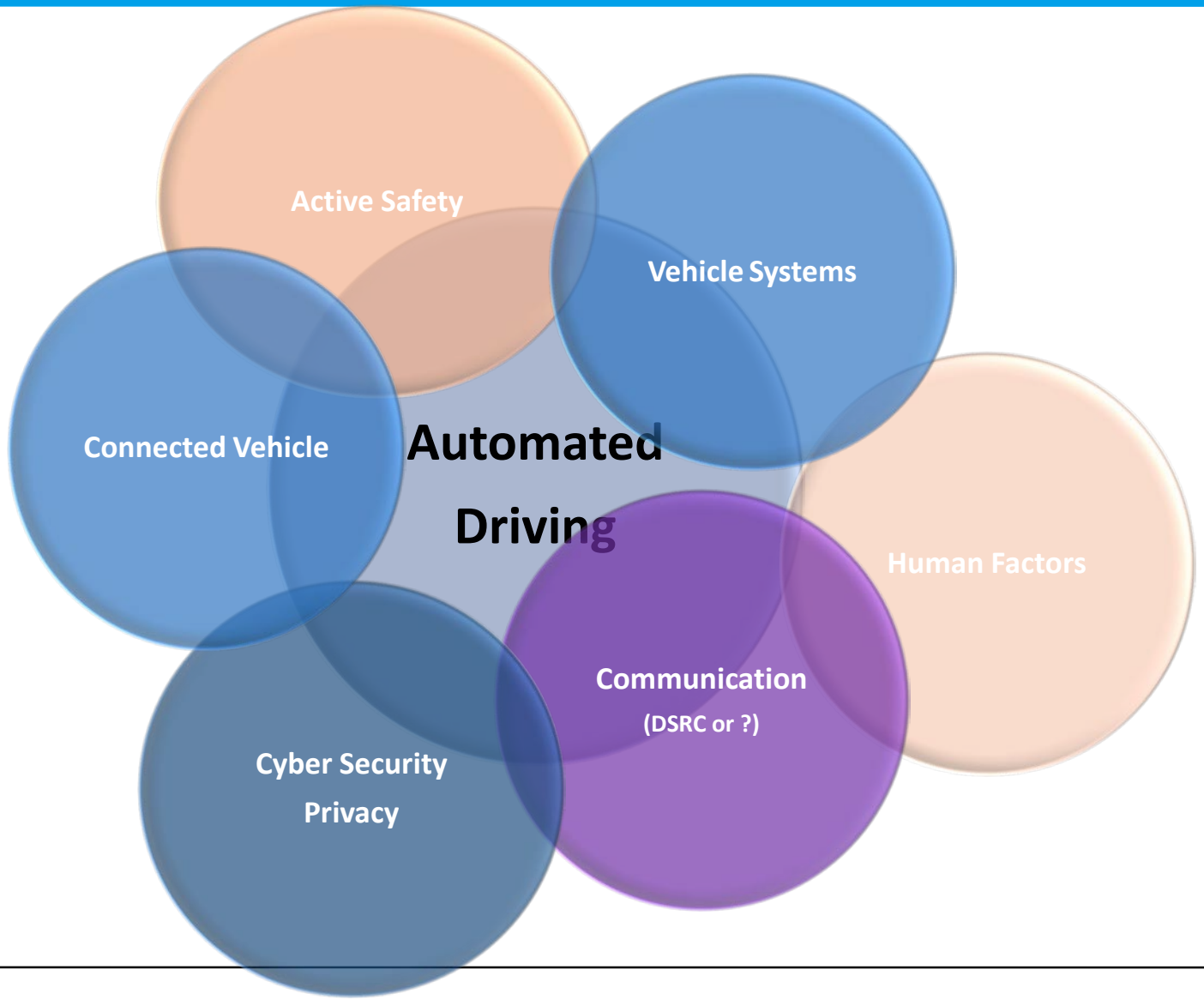


Active Safety

Vehicle Electronics Cyber Security

Intelligent Transportation Systems

Fundamental Relationships & Work at SAE: Automated Driving Systems



Applications

Driving Task / Driver's Tasks

- Pre-Trip
- Roadside
- OOS
- Incident
- P & D (LTL / Cartage)
- Maintenance
- Diagnostics
- Logistics
- Vocational

Historical Perspectives: Enabling Technologies: Driver Assistance

Architecture Examples:

- SAE J560
- SAE J1939 (&J1587, J1708)
- Sensor and Component Developments
- ABS
- Electronic Engine Controls
- Automated Manual Transmissions
- Electronically Controlled Braking Systems
- Roll Stability Control / Electronic Stability Control Systems
- Adaptive Cruise Control (Terrain Function)
- Road/Lane Departure Warning Systems
- Automatic Emergency Braking

Evolution or Revolution: Equipment & Societal/Institutional

Established, Traditional, Legacy Suppliers

- **Vehicle Manufacturers**
- **Major Component Suppliers / Strategic Development Partners**
- **Vertically Integrated Divisions**
- **Lower Tier Suppliers**
- **Modifiers / Body/Equipment Installers**
- **Aftermarket / Direct to End User Technology Providers**

New Entrants' / Entrepreneurs' Dynamics (Disrupters)

General Public Perception

Motor Carriers

Law Enforcement

Regulators/Legislators

Special Interest Groups

Evolution or Revolution (continued)

- Closed
- Geofenced
- Conservative Domain
- Conservative Progression
- Regulated
- Disruptive

Recent Studies / Predictions:

- TNO (2016)
- ITF (2015)
- Frisoni et al (2016)
- Underwood (2014)
- PWC (2015)
- KPMG (2015)
- SAFE (2017)
- …

Published and Works In Progress

Terms and Definitions

- Taxonomy & Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems
- Operational Definitions of Driving Performance Measures & Statistics
- Definition of Hand-Free Operation of a Person to Person Wireless Communication System or Device
- Automated Vehicles Definitions: Key Terms Related to Human Interaction with Automated Driving Systems
- Active Safety Systems Sensors

Vehicle & System Performance Requirements

- DSRC Common Performance Requirements
- On-Board System Requirements for V2V Safety Communications
- Performance Requirements for Cooperative Adaptive Cruise Control and Platooning
- Performance Requirements for Safety Communications to Vulnerable Road Users
- Automatic Emergency Braking Test Methods and Performance Assessment
- Adaptive Cruise Control Operating Characteristics and User Interface
- Recommended Practice for Pas-Thru Vehicle Programming
- Automated Driving Reference Architecture

Interoperability (V2V, V2I, V2X)

- Dedicated Short Range Communication (DSRC) Message Set Dictionary
- On-Board System Requirements for V2V Safety Communications
- DSRC Requirements for V2V Safety Awareness
- Candidate Improvements to DSRC Using Systems Engineering Methods
- Mobile Device Application
- Road Side Equipment for I2V and V2I
- Performance Requirements for Safety Communications to Vulnerable Road Users
- Recommended Practices for MAP/SPaT Message Development
- Recommended Practices for Signal Preemption Message Development
- Recommended Practice for Pass-Through Vehicle Programming
- Automated Driving Reference Architecture

SAE J3016 Standards for Automated Driving

AUTOMATED DRIVING

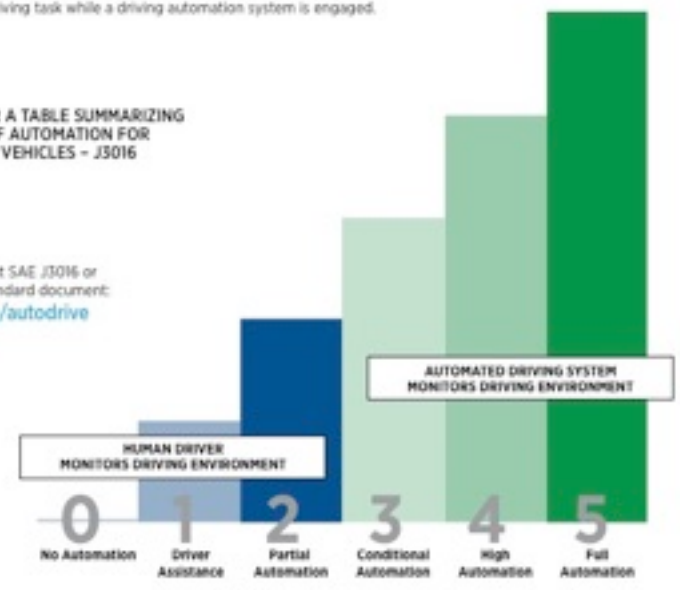
LEVELS OF DRIVING AUTOMATION ARE DEFINED IN NEW SAE INTERNATIONAL STANDARD J3016

With the goal of providing common terminology for automated driving, SAE International's new standard J3016: **Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems**, delivers a harmonized classification system and supporting definitions that:

- Identify six levels of driving automation from "no automation" to "full automation".
- Base definitions and levels on functional aspects of technology.
- Describe categorical distinctions for a step-wise progression through the levels.
- Are consistent with current industry practice.
- Eliminate confusion and are useful across numerous disciplines (engineering, legal, media, and public discourse).
- Educate a wider community by clarifying for each level what role (if any) drivers have in performing the dynamic driving task while a driving automation system is engaged.

OVER FOR A TABLE SUMMARIZING LEVELS OF AUTOMATION FOR ON-ROAD VEHICLES – J3016

Learn more about SAE J3016 or purchase the standard document: www.sae.org/autodrive



SUMMARY OF SAE INTERNATIONAL'S LEVELS OF DRIVING AUTOMATION FOR ON-ROAD VEHICLES

Issued January 2014, **SAE international's J3016** provides a common taxonomy and definitions for automated driving in order to simplify communication and facilitate collaboration within technical and policy domains. It defines more than a **dozen key terms**, including those italicized below, and provides **full descriptions and examples** for each level.

The report's **six levels of driving automation** span from *no automation* to *full automation*. A **key distinction** is between level 2, where the *human driver* performs part of the *dynamic driving task*, and level 3, where the *automated driving system* performs the entire *dynamic driving task*.

These levels are **descriptive** rather than normative and **technical** rather than legal. They imply **no particular order** of market introduction. Elements indicate **minimum** rather than maximum system capabilities for each level. A particular vehicle may have multiple driving automation features such that it could operate at **different levels** depending upon the feature(s) that are engaged.

System refers to the driver assistance system, combination of driver assistance systems, or *automated driving system*. **Excluded** are **warning and momentary intervention systems**, which do not automate any part of the *dynamic driving task* on a sustained basis and therefore do not change the *human driver's* role in performing the *dynamic driving* task.

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Key definitions in J3016 include (among others):

Dynamic driving task includes the operational (steering, braking, accelerating, monitoring the vehicle and roadway) and tactical (responding to events, determining when to change lanes, turn, use signals, etc.) aspects of the driving task, but not the strategic (determining destinations and waypoints) aspect of the driving task.

Driving mode is a type of driving scenario with characteristic *dynamic driving task* requirements (e.g., expressway merging, high speed cruising, low speed traffic jam, closed-campus operations, etc.).

Request to intervene is notification by the *automated driving system* to a *human driver* that s/he should promptly begin or resume performance of the *dynamic driving task*.

Contact: SAE INTERNATIONAL +1.724.776.4841 • Global Ground Vehicle Standards +1.248.273.2455 • Asia+86.21.61577368

P141661

Published and Works in Progress: Safety (sample)

Functional Safety

Safety and Reliability

Active Safety

Safety & Human Factors

Other Safety / Crosscutting

Published and Works in Progress: Safety (sample)

Functional Safety

Safety and Reliability

Active Safety

Safety & Human Factors

Other Safety / Crosscutting

Advanced Driver Assistance Systems & Levels of Automation

- Active Safety Systems Sensors
- Automatic Emergency Braking Test Methods & Performance Assessment
- Specifications of Pedestrian Mannequins for Vehicle Pedestrian Detection Systems
- Truck & Bus Lane Departure Warning Systems Test Procedure
- Truck & Bus Forward Collision Warning & Mitigation Vehicle Test Procedure
- Recommended Practice for Braking, Stability, & Control Performance Test Procedure of Air-Brake-Equipped Trucks
- Taxonomy & Definitions for Terms related to On-Road Motor Vehicle Automated driving Systems
- Test Target Correlation

Published and Works in Progress: Safety (sample)

Functional Safety

Safety and Reliability

Active Safety

Safety & Human Factors

Other Safety / Crosscutting

Advanced Driver Assistance Systems & Levels of Automation

- Active Safety Systems Sensors
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Other Safety

- Truck & Bus Automated Commercial Vehicle
- Uniform Pavement Markings for Machine Vision Systems
- Adaptive Driving Beam System
- Guidelines for Safe On-Road Testing of Automated Driving Systems
- Identifying Automated Driving System Dedicated Vehicles (ADS-DV) User Issues for Persons With Disabilities

Published and Works in Progress

Privacy

- Data Collection, Retention, Ownership & Access
- Pedestrian Protection EDR Parameters
- Permanently or Semi-Permanently Installed Diagnostic Communication Devices

Security

- Cybersecurity Recommended Practice for Cyber-Physical Vehicle Systems
- Requirements for Hardware Protected Security for Ground Vehicle Applications
- OBD II Telematics, Vehicle Health Management, Data Access
- Vulnerabilities & Cyber Threat Analysis
- Over the Air Updates
- Automotive Networks of Connected Systems, Sensors & Physical Objects

SAE Cybersecurity Standards

SAE J3061 "Cybersecurity Guidebook for Cyber-Physical Automotive Systems"

Scope:

- Consistent with Process Framework for ISO 26262 Functional Safety Standard
- Contains automotive cybersecurity framework and processes
- Evaluates Threat Analysis and Risk Assessment (TARA) methods
- Simple approach to allow effective implementation across the automotive industry
- Contains elements of existing industry security standards
- Definitions, Acronyms, and sample templates provided

SAE J3101: "Requirements for Hardware-Protected Security for Ground Vehicle Applications"

Scope:

Define a common set of requirements for security to be implemented in hardware for ground vehicles to facilitate security enhanced applications, developing expectations for necessary functionality to achieve an ideal system for hardware protection for ground vehicle applications, including examples, but not explicitly detailing implementation requirements.

SAE INTERNATIONAL

Thank you

Bill Gouse
202.281.5844
S.William.Gouse@sae.org

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