Automated Vehicle Safety Consortium™
A Program of SAE ITC

Evaluation of Behavioral Competencies for Automated Driving System Dedicated Vehicles

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Automated **V**ehicle **S**afety **C**onsortium™

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AVSC's Mission

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.

- Inform AV pilot projects / deployments as they become more widespread

- Leverage safety expertise and culture of safety

- Publish our work to accelerate formal, global standards

- Consortium Members implement as appropriate within their organizations

SAE Group

SAE ITC
An SAE International Affiliate
(PA not-for-profit Corp)
IRC 501(c)(6)

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ARINC IA	WMC/PIN
ASPQP	IAMTS
SAE AMS-AMDC	Mobility Data Collaborative
ExchangeWell	DATC
IBIS	Probitas
AESQ	HRCS

SAE INTERNATIONAL®
(PA not-for-profit Corp)
IRC 501(c)(3)

Standards

Conferences

Publications

Professional Development

Pre-professional

Sections

PRI PERFORMANCE REVIEW INSTITUTE
(PA not-for-profit Corp)
IRC 501(c)(6)

Process accreditation

Nadcap	MedAccred
Quality Mgt	Registrar
Training	Bodies of Knowledge

Accelerate Standards Development

AVSC best practices introduced into committees for discussion, modification, and potential inclusion into SAE J-standards and / or other global standards development work

Automated Vehicle Safety Consortium (AVSC)

Relationship with Open Standards
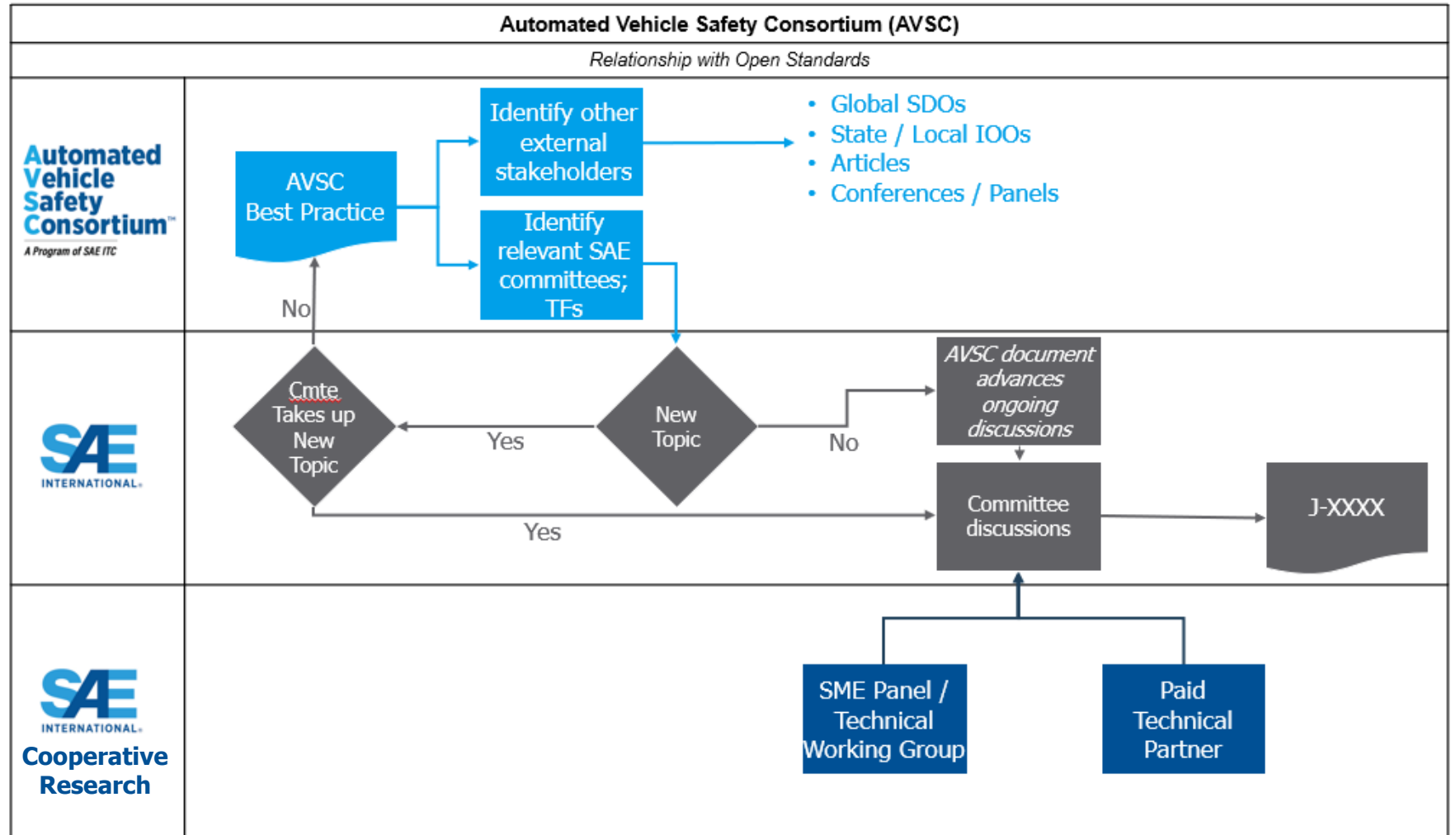
How We Work

Technology neutral

- Describe the "what" and leave the "how" for each organization to determine

Complementary

- Leverage and reference the good work of others
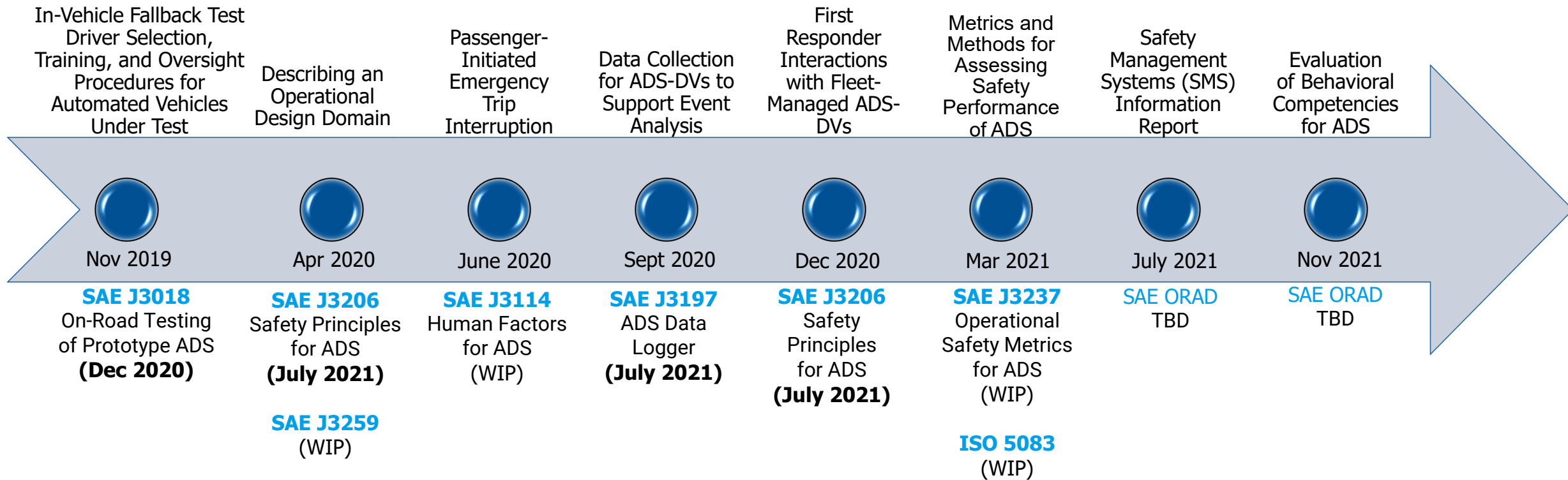- Complement the work of others, avoiding duplication

Common interest

- Openly share current practices of common interest
- Describe challenges to consensus

Accelerate standards

- Introduce work to SAE and global SDOs
- Best practices are easily accessible

Best practices and Standards Acceleration

In-Vehicle Fallback Test Driver Selection, Training, and Oversight Procedures for Automated Vehicles Under Test

Describing an Operational Design Domain

Passenger-Initiated Emergency Trip Interruption

Data Collection for ADS-DVs to Support Event Analysis

First Responder Interactions with Fleet-Managed ADS-DVs

Metrics and Methods for Assessing Safety Performance of ADS

Safety Management Systems (SMS) Information Report

Evaluation of Behavioral Competencies for ADS

| Nov 2019 | Apr 2020 | June 2020 | Sept 2020 | Dec 2020 | Mar 2021 | July 2021 | Nov 2021 |

SAE J3018
On-Road Testing of Prototype ADS
(Dec 2020)

SAE J3206
Safety Principles for ADS
(July 2021)

SAE J3259
(WIP)

SAE J3114
Human Factors for ADS
(WIP)

SAE J3197
ADS Data Logger
(July 2021)

SAE J3206
Safety Principles for ADS
(July 2021)

SAE J3237
Operational Safety Metrics for ADS
(WIP)

ISO 5083
(WIP)

SAE ORAD
TBD

SAE ORAD
TBD

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Evaluation of Behavioral Competencies
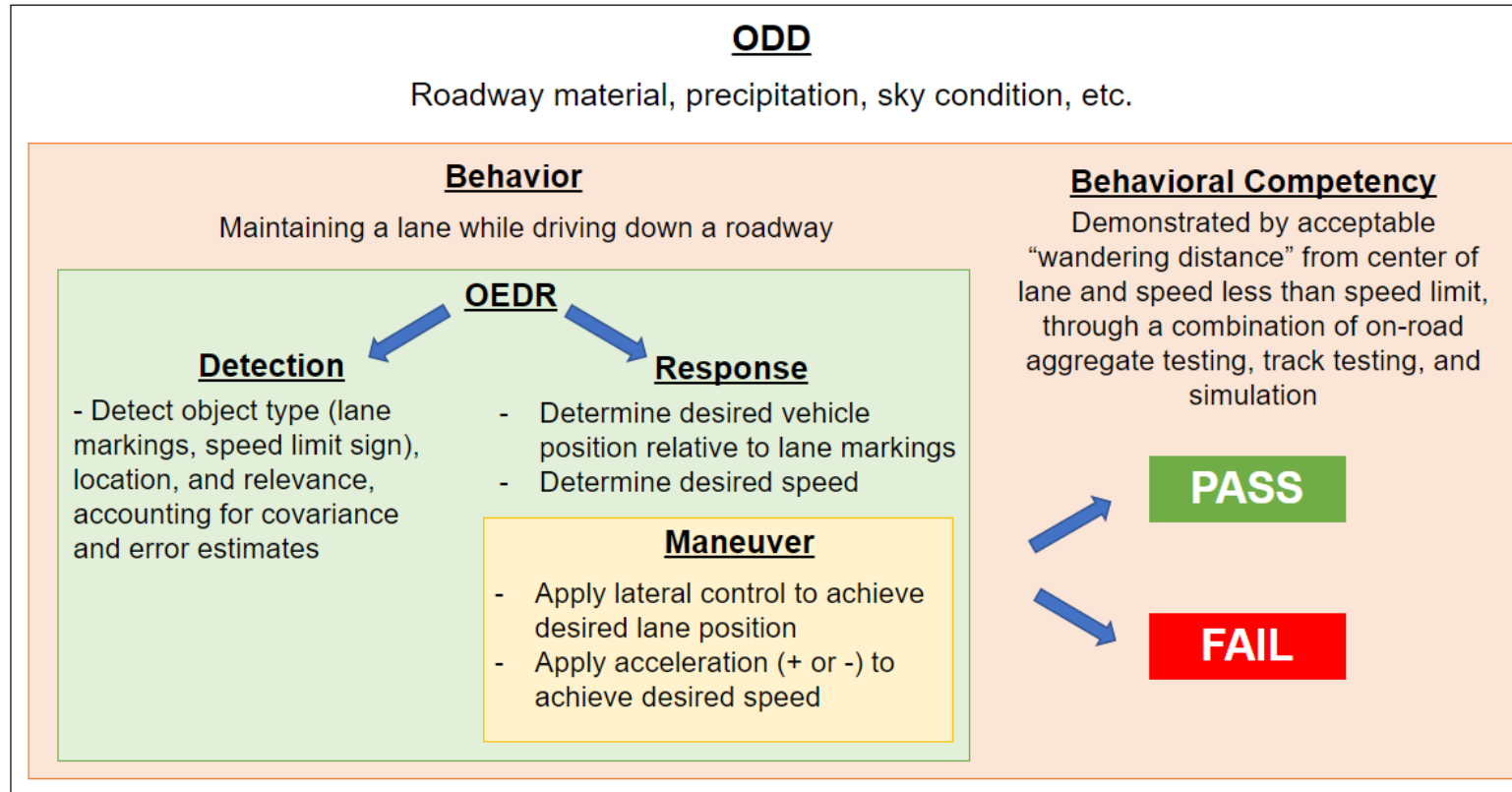
Why -

- Driving safely is a complex task involving a broad range of skill sets invoked in a vast number of potential scenarios

- There is value in assessing a set of behavioral competencies as directional indication of safety performance

- Elemental Behaviors can be used as starting point for additional assessment

What -

- Clarity on lexicon and relationship between maneuvers, OEDR and behaviors

- Glimpse into how AVSC members are using behavioral competencies within their organizations as part of a safety assurance framework

- Elemental behavioral competency list can be used and customized by developers to demonstrate safety performance in whatever context they choose

- Example of a repeatable method to tie in previous work of AVSC (ODD, Metrics) to develop application-specific metrics, using "Maintaining a Lane" to illustrate.

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Components of Behavioral Competencies

AVSC members recommend a lexicon to enable communication of safety performance and clarify across industry in terms of behavioral competency

ODD
Roadway material, precipitation, sky condition, etc.

Behavior
Maintaining a lane while driving down a roadway

OEDR

Detection
- Detect object type (lane markings, speed limit sign), location, and relevance, accounting for covariance and error estimates

Response
- Determine desired vehicle position relative to lane markings
- Determine desired speed

Maneuver
- Apply lateral control to achieve desired lane position
- Apply acceleration (+ or -) to achieve desired speed

Behavioral Competency
Demonstrated by acceptable "wandering distance" from center of lane and speed less than speed limit, through a combination of on-road aggregate testing, track testing, and simulation

PASS

FAIL

Defining Behavioral Competencies

AVSC members are using behavioral competencies within their organizations as part of a safety assurance framework.
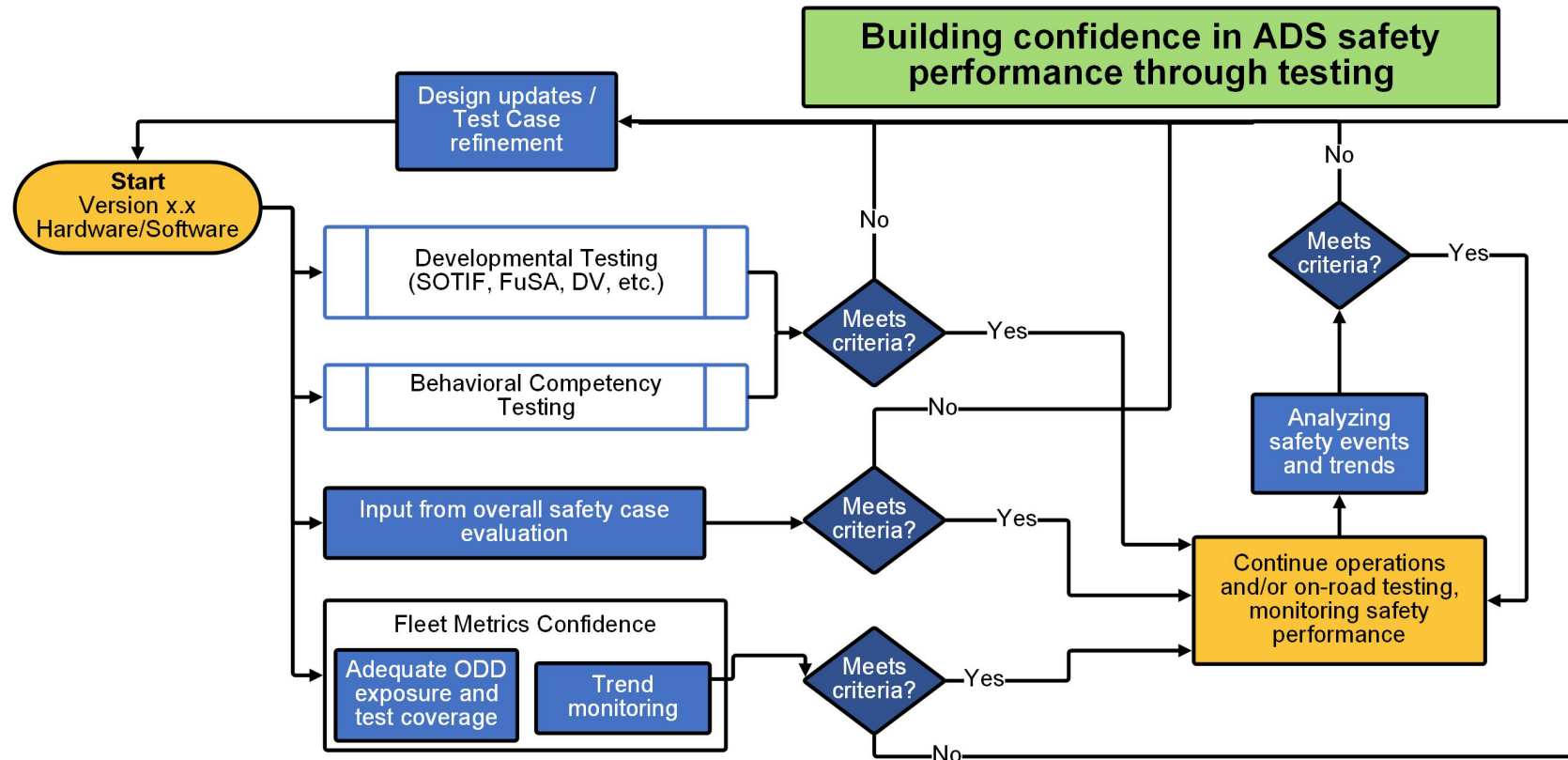
Elemental Behavioral Competencies

ADS developers and manufacturers can use this elemental set of behavioral competencies as starting points for behavioral competency testing.

	Behavior
Roadway Infrastructure	Maintaining a lane
	Changing lanes
	Navigating Intersection
	Navigating, entering, exiting, unstructured roadways
	Navigating pick up and drop off zones and parking situations
Dynamic Conditions	Responding to vulnerable road users (VRUs)
	Responding to other vehicles
	Responding to special purpose vehicles
	Responding to lane obstructions and obstacles
	Responding to confined road structures
	Responding to work zones
	Responding to DDT performance-relevant failure [SAE J3016]
	Responding to relevant traffic control devices

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Applying Metrics for Behavioral Competencies

Example of a repeatable method to tie in previous work of AVSC (ODD, Metrics) to develop application-specific metrics, using "Maintaining a Lane" to illustrate.

Select one or more behavioral competency → Identify contextual elements in ODD (AVSC00002202004) → Decompose into scenarios → Develop applicable metrics (AVSC0006202103) → Define relevant acceptance criteria

Behavior		Context
Roadway Infrastructure	Maintaining a lane	Lane marking type, width and quality
		Precipitation type and intensity
		Sky condition
		Roadway material
		Road surface condition
Dynamic Conditions	Responding to other vehicles	Presence of lead vehicle only (no cut ins, etc.)
		Size/type of lead vehicle

AVSC Metrics to Support ADS Safety

High-level goals for desired societal impact were used as guidance:

- Reduce the number of severity of crashes
- Perform contextually safe vehicle motion control

Recommended metrics were developed based on:

- Established relationship to safety outcomes for human drivers
- Can be measured and assessed practicably
- Technology neutral, practicable, and can be consistently applied

Table 1: Recommended set of safety performance metrics for ADS developers and manufacturers

Category	Safety Performance Metrics
Crashes	Crash severity and frequency
Compliance with traffic regulations	Severity and frequency of citable offense
Maintain a safety envelope	Longitudinal and lateral distance (may be a function of contextual modifiers
Exhibit contextually safe vehicle motion control	Acceleration (longitudinal and lateral Jerk (longitudinal and lateral)
Object and event detection and response (OEDR)	OEDR reaction time

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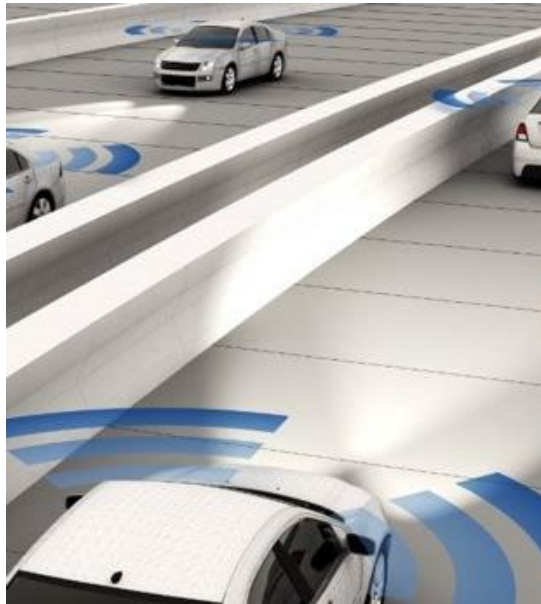
2022

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THANK YOU