



Autonomous Vehicle Safety Analysis and Assessment (NTPS)

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Overview

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Introduction

Introduction

What is an Autonomous Vehicle:

- ▶ A self-driving vehicle is capable of sensing and perceiving the environment and thereby planning and controlling the vehicle in the most optimized way to achieve the target.
- ▶ Has been in development from as early as the 1920s.
- ▶ Upto Level 3 automation has been achieved, but Level 4 and Level 5 are still in the testing and validation state.

Introduction

Safety and Security of Autonomous Vehicles:

- ▶ Mass deployment of the autonomous vehicle can only be done when the safety and security of autonomous vehicles have been achieved.
- ▶ Testing and validation have to follow the defined standards that also match the rapidly changing technology behind AVs.
- ▶ Concern related to reliability, dependability, liability and optimality regarding AVs has to be addressed.

Levels of Autonomy

Levels of Autonomy

Degree of automation Defined by SAE J3061 standards:

- ▶ Six levels of Autonomy have been defined with no automation to full automation.
- ▶ From Level 0 to Level 3, the driver has to drive with the help of driving assistance functionalities and take full responsibility.
- ▶ Level 4 and Level 5, the driver doesn't have to drive and take responsibility.
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Figures

SAE J3016 LEVELS OF DRIVING AUTOMATION

	SAE LEVEL 0	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
What does the human in driver's seat have to do?	You are driving whenever these driver support features are engaged - even if your feet are off the pedals and you are not steering			You are not driving when these automated driving features are engaged - even if you are seated in "the driver's seat"		
	You Must constantly supervise these support features; you must steer, break or accelerate as needed to maintain safety			When the feature request, you must drive	These automated driving features will not require you to take over driving	
What do these features do?	These are driver support features			These are automated driving features		
	These features are limited to providing warnings and momentary assistance	These features provide steering OR break/ acceleration support to driver	These features provide steering AND break/ acceleration support to driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met	These features can drive the vehicle under all condition	
Example Features	<ul style="list-style-type: none">• automatic emergency breaking• bliend spot warning• lane departure warning	<ul style="list-style-type: none">• lane centering OR <ul style="list-style-type: none">• adaptive cruise control	<ul style="list-style-type: none">• lane centering AND <ul style="list-style-type: none">• adaptive cruise control at the same time	<ul style="list-style-type: none">• traffic jam chauffeur	<ul style="list-style-type: none">• local driverless taxi• pedals/steering wheel may or may not be installed	<ul style="list-style-type: none">• same as level 4, but feature can drive in all conditions

Figure: SAE J3061: Level of Autonomy

Autonomous Vehicle Architecture

Autonomous Vehicle Architecture

There are four major modules in AV architecture:

- ▶ Perception
- ▶ Mapping and Localization
- ▶ Planning
- ▶ Control

Autonomous Vehicle Architecture

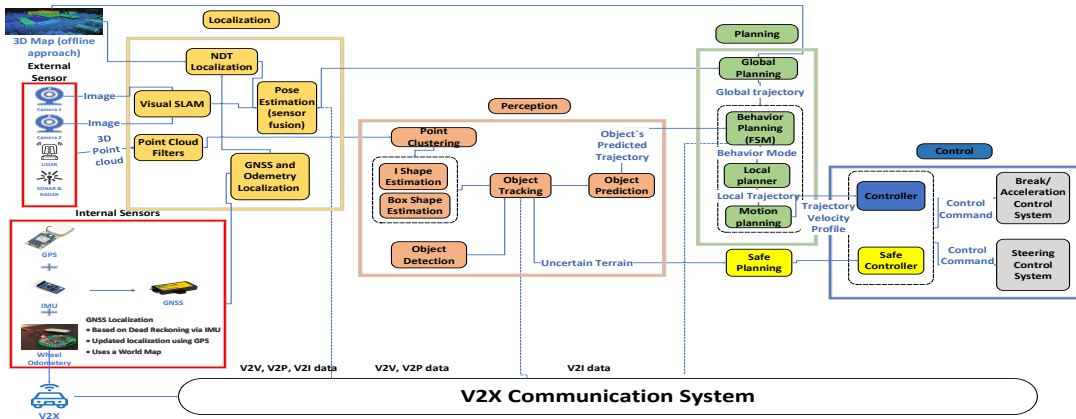


Figure: Autonomous Vehicle Architecture

Safety and Security Standards for AVs

Safety and Security Standards for AVs

Standard	Title	Organization
ISO 21448	Road Vehicles - Safety of the Intended Functionality (SOTIF)	International Organization for Standardization (ISO)
ISO 26262	Road Vehicles - Functional Safety	International Organization for Standardization (ISO)
SAE J3016	Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles	Society of Automotive Engineers (SAE)
SAE J3061	Cybersecurity Guidebook for Cyber-Physical Vehicle Systems	Society of Automotive Engineers (SAE)
UL 4600	Standard for Safety for the Evaluation of Autonomous Products	Underwriters Laboratories (UL)
IEEE 2846	Standard for Safety and Testing Requirements for Highly Automated Vehicles	Institute of Electrical and Electronics Engineers (IEEE)
EN 303 645	Cyber Security for Consumer Internet of Things	European Committee for Standardization (CEN)

Safety and Security Standards for AVs

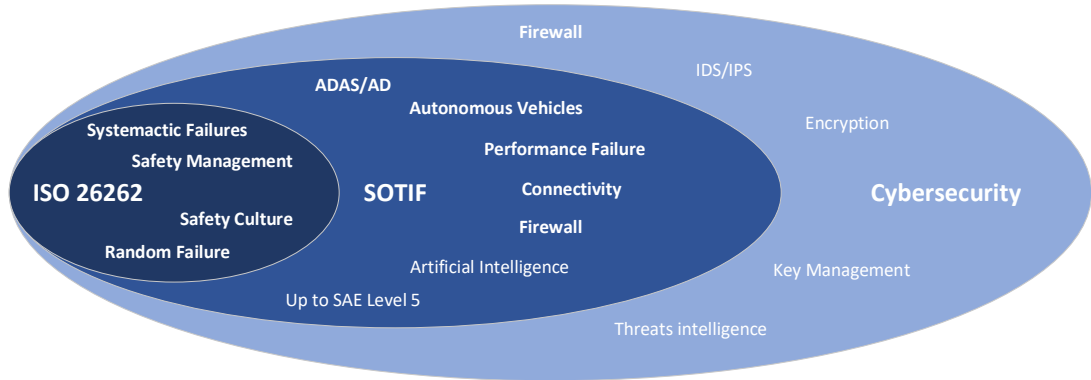


Figure: Autonomous Vehicle Safety and Security Standard

Conclusion

Conclusion

Challenges in Achieving Safety and Security:

- ▶ Cybersecurity & Data Privacy
- ▶ Complex software and hardware
- ▶ Human-machine interaction
- ▶ Environmental conditions & Infrastructure readiness
- ▶ Ethical considerations and dilemmas
- ▶ Safety certification and Regulatory hurdles
- ▶ Public trust and acceptance
- ▶ Liability and insurance
- ▶ Limited testing environments & Cost

Conclusion

State-of-the-Art Purposed Solution:

- ▶ Redundant, Diverse and Advance sensors
- ▶ Machine Learning and Artificial Intelligence (Data Driven Control)
- ▶ Blockchain technology & Cybersecurity solutions
- ▶ Communication Standards (V2X)
- ▶ Secure Intra-Communication Network
- ▶ Test and validation frameworks
- ▶ Standards and regulations
- ▶ Human Factors



Thanks for your attention!

Are there questions?