21.05.11 ARCADE Workshop on Edge Cases

Narrowing down edge cases

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Reliable Autonomous Vehicles

We will continue making noise…

METI
Ministry of Economy, Trade and Industry

MLIT
Ministry of Land, Infrastructure, Transport and Tourism

Cabinet Office

Definitions of edge cases

Edge cases occur rarely but may be difficult for a self-driving vehicle to resolve and result in injuries or the loss of life. Although these events are rare, under the assumption that edge case occurs once per one million times to drivers per year, with a fleet of 30 million vehicles, it is acceptable to consider 30 events to occur per year

Zeyn SAIGOL and Alan PETERS. ITS World Congress. 2018

Edge Case are surprises. You won't see these in testing. Edge cases are the stuff you didn't think of!. Expect the extreme, weird, unusual

Phillip Koopman, Edge Cases and AV Safety SSS 2019

Definitions of edge cases

The remaining risk of unforeseen conditions that are in the real ODD but not in the specficiation or test cases.

Bernhard Kaiser, Defining and Structuring ODD and Usage Scenarios for SOTIF Ideation, Workshop ASAM OpenODD 2020

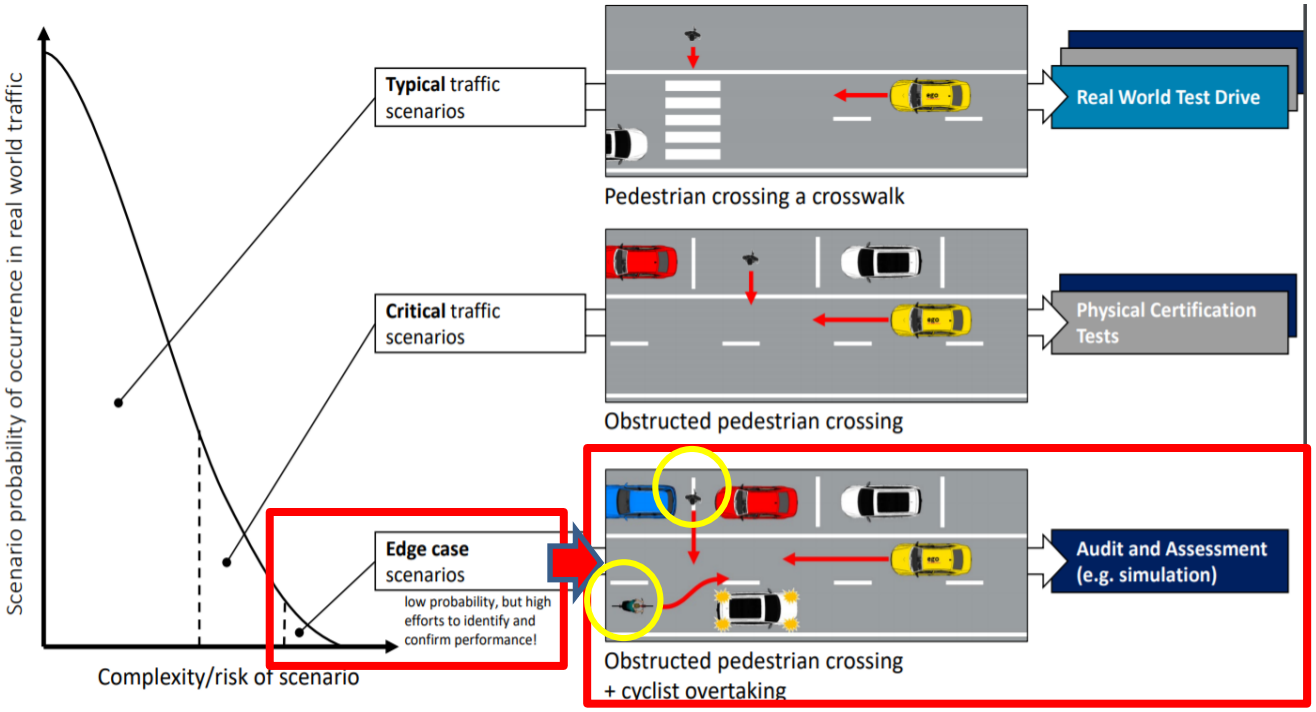

Fig 1. Obscrution Edge case.

Informal document GRVA-02-09 2nd GRVA, 28 January – 1 February 2019 Agenda item 5 (a)

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Edge cases in context with SOTIF

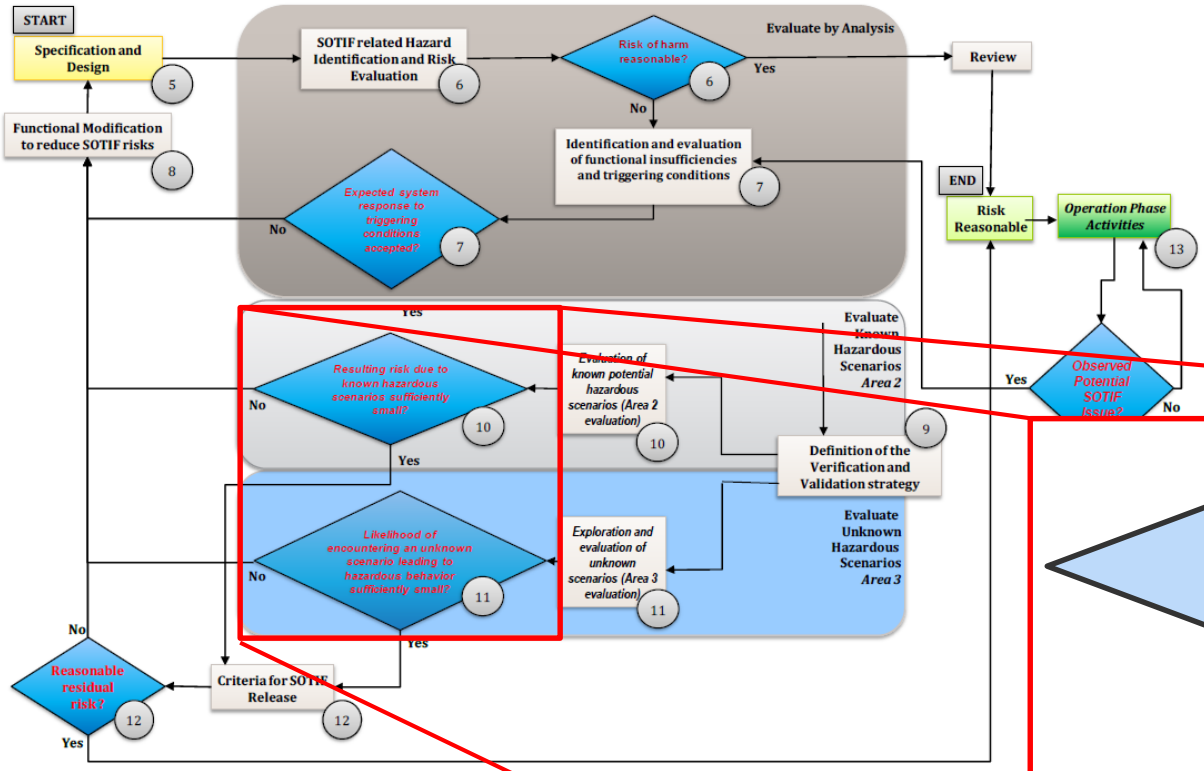
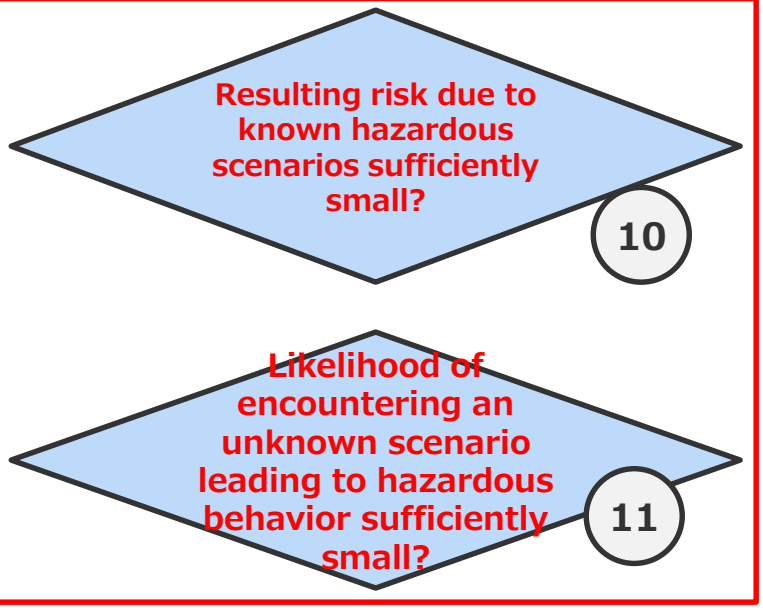


Figure 5 — Dependency of the ISO 21448 activities

ISO®



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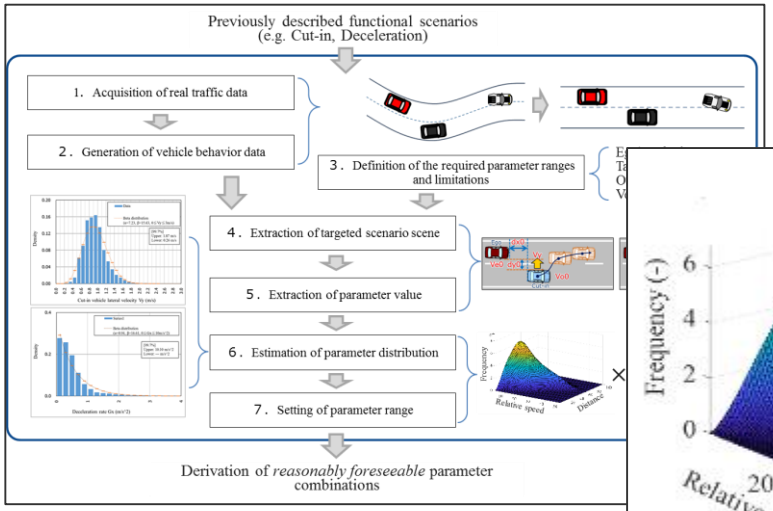
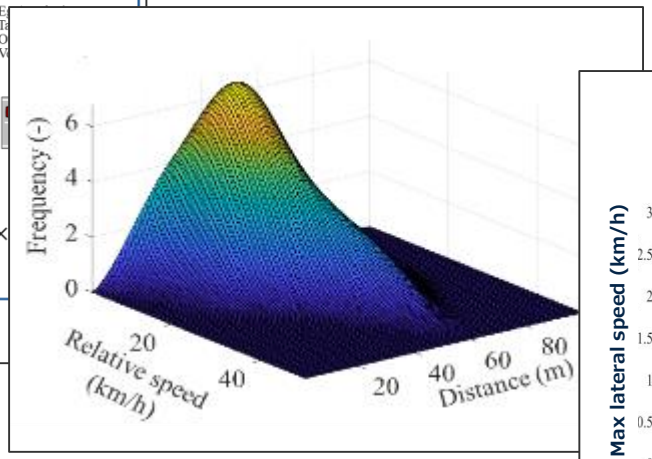
Narrowing down edge cases (1)

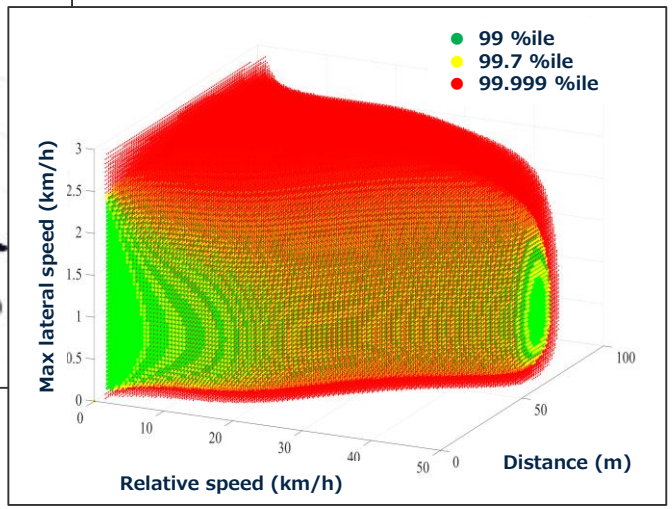
Clear definitions of what is reasonably foreseeable and socially acceptable can help to narrow down the focus to the most relevant edge cases



Extraction of scenario parameter distributions from real traffic data



Scenario-dependent reasonably foreseeable parameter ranges



Scenario parameter ranges considering exposure and risk acceptance levels

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Nakamura et al. 2021, Defining reasonably foreseeable vehicle parameter ranges for scenario-based testing of automated vehicles in consideration of risk acceptance. Pre-print: https://www.sakura-prj.go.jp/news/?itemid=20&dispmid=416

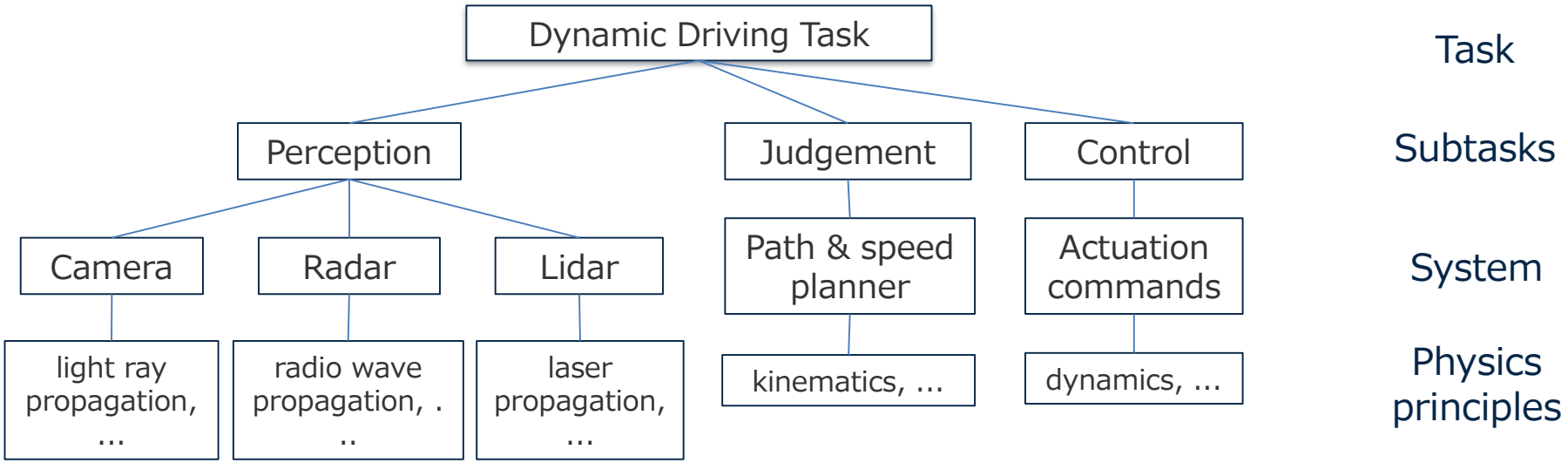
Narrowing down edge cases (2)

Approaching hazardous scenarios (including edge cases) from the physics principles of the AD system

Infinite number of safety-relevant situations the AD system may meet

vs

Limited number of physical principles that an AD system can rely on



If hazardous scenarios are decomposed and logically structuralized in accordance with the physics of the AD system, then it is possible to provide a holistic coverage of all safety-relevant root causes for each given DDT.

Narrowing down edge cases (3)

Learning from past, present and future crashes and near crashes

U.S. Department of Transportation
National Highway Traffic Safety Administration

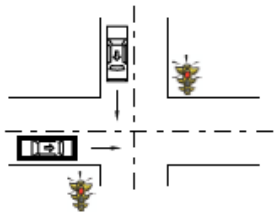
NHTSA
www.nhtsa.gov

DOT HS 810 767 April 2007

Pre-Crash Scenario Typology for Crash Avoidance Research

Running red light

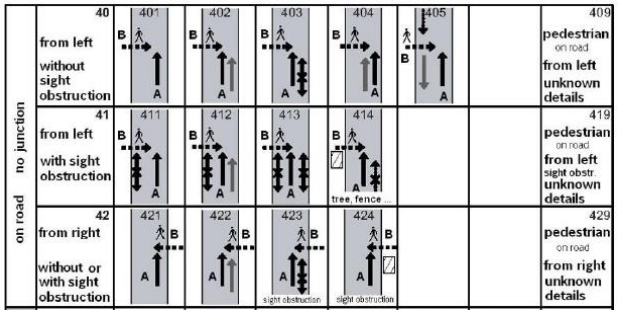
Crash Severity		Scenario	Scenario/All
No. of crashes		254,000	4.27%
No. of vehicles involved		528,000	4.94%
No. of people involved		740,000	4.92%
Societal Cost	Economic cost	$6,627,000,000	5.53%
	Functional years lost	135,000	4.87%



IGLAD
INITIATIVE FOR THE GLOBAL HARMONISATION OF ACCIDENT DATA

Codebook

Member Year 2019



VIRGINIA TECH TRANSPORTATION INSTITUTE

AUTOMATED MOBILITY PARTNERSHIP

Fraunhofer IVI

PASTAS JP

Police Accident Scenarios and Toolchain for Assessment Simulation for Japanese accident data

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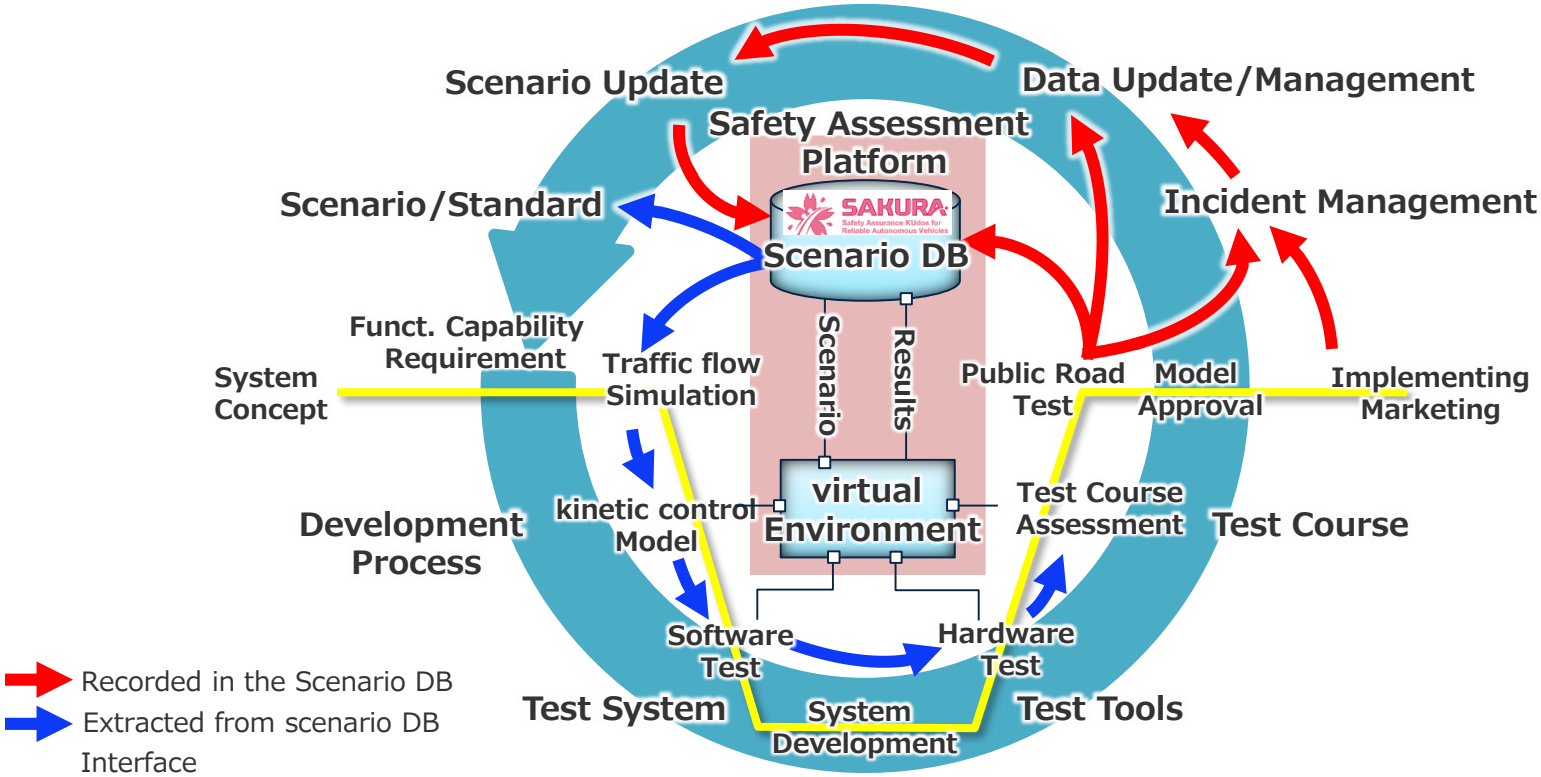
Narrowing down edge cases (4)

Establishing a continuous AD Safety Evaluation eco-system for AD Development and safety evaluation



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Summary

- Clear definitions of what is reasonably foreseeable, what is preventable and what can be socially accepted will help to narrow down the focus to the most relevant edge cases.
- Decomposition of scenarios (including edge cases) from the perspective of the physics of the systems until the root causes are known and addressed.
- Learning from past, present and future crashes and near crashes, and establishing a continuous AD safety evaluation eco-system for AD development and safety evaluation.

Thank you

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