2026.3.5 SAKURA Final Event

SAKURA

Safety Assurance KUdos for
Reliable Autonomous Vehicles

SAKURA Project Overview

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Introduction: Sou Kitajima
Japan Automobile Research Institute, Senior Researcher

- **Personal history**

  - 2012   Receiving PhD from University of Tsukuba
  - 2015 -18   National research project funded by Cabinet office (Project Chief)
  - 2016 -17   Development of Automated Driving Test Center (Project Chief)
  - 2018 -   National research project funded by METI (Project Manager)
           (SAKURA : Safety Assurance KUdos for Reliable Autonomous vehicles)
  - 2023 -   Associate Professor of University of Tsukuba
           (Collaborative Graduate School Program)

- **Record of awards**

  - 2016   JSME 26th TRANSLOG Best Presentation Award
  - 2018   62nd AAAM (Association for the Advancement of Automotive Medicine) Best Poster Award
  - 2019   JSAE 69th Award (Technology Development Award)
  - 2023   7th FAST-zero'23 (Future Active Safety Technology toward zero traffic accidents) Best Paper Award
  - 2025   JSAE 2025 Spring Congress Best Presentation Award

LinkedIn   **ResearchGate**

Multi-agent Traffic sim.

1. **Looking back of SAKURA project (2018-2025)**

2. **SAKURA project outcomes**

   (1) Defining reasonable foreseeability

   (2) Defining preventability

   (3) Provision sufficient and necessary scenarios

3. **Concluding remarks**

1. Looking back of SAKURA project (2018-2026)

● **Realization of Automated Driving Systems**

✓ **Automated Driving System (ADSs)**
- Key technology for future mobility
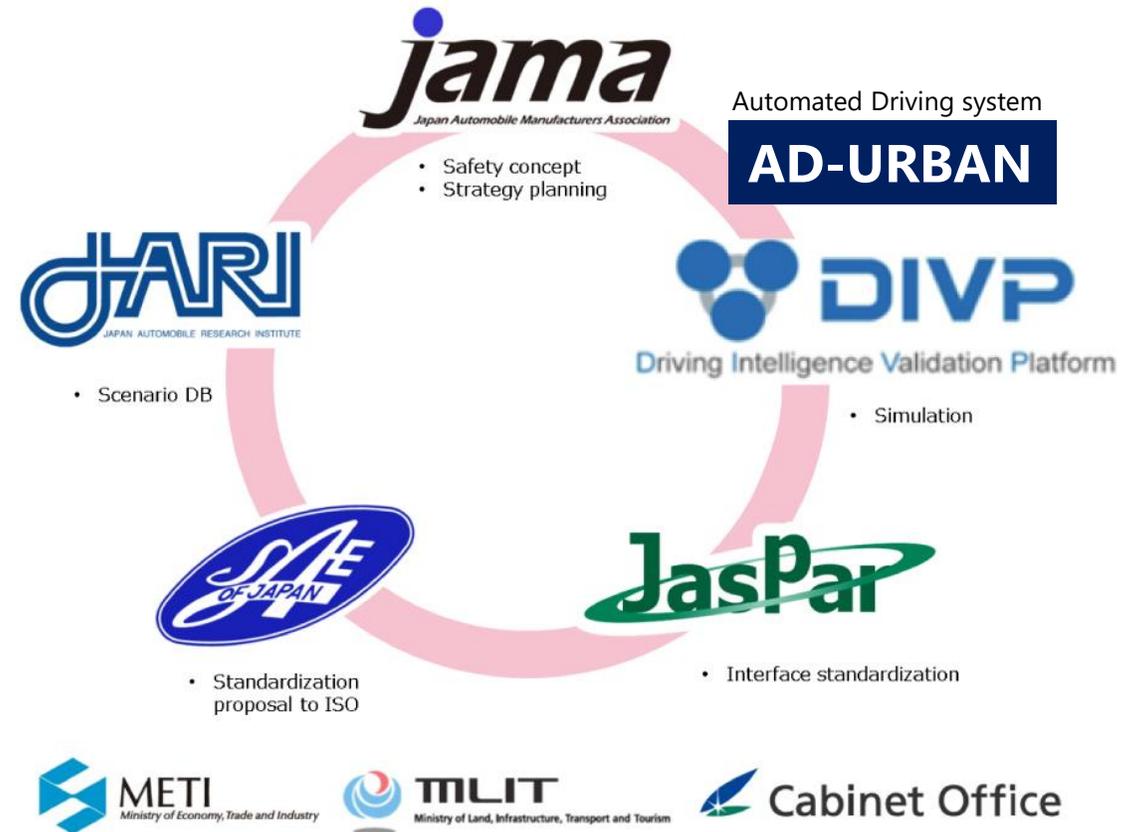- Need for new safety assurance and evaluation methodology

PEGASUS project (Germany)
- Scenario-based safety evaluation
- 6 layered scenario structure

✓ **All-Japan initiatives**
- Contribution for international rule making (standard/regulation)

Safety evaluation methods for ADS through international collaboration

● **Our goal**

SAKURA
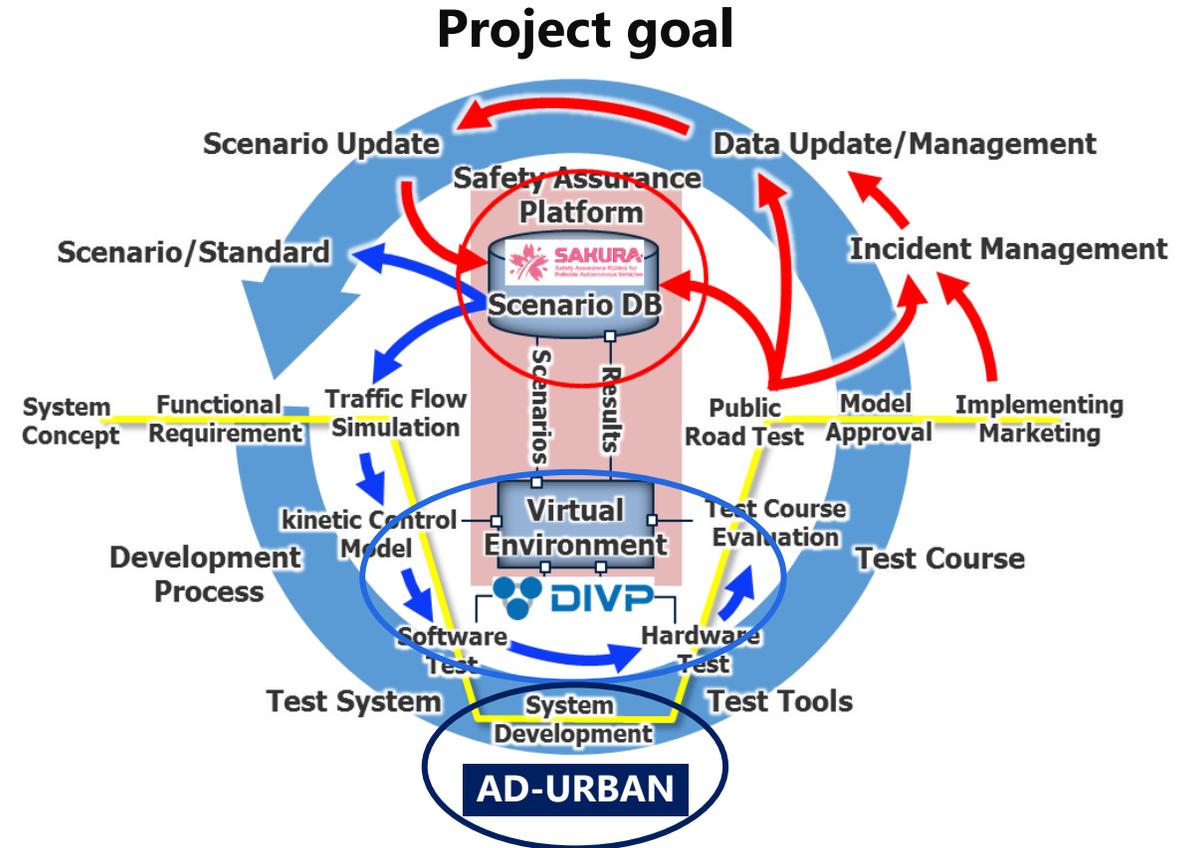
Safety **A**ssurance **KU**dos for **R**eliable **A**utonomous vehicle

- Proposing safety assurance concept
- Contribution to ISO/UNECE

✓ **Eco-system for safer AD developing**

1. Utilizing scenario from upstream
2. Linkage to simulation platform
3. Continuous updated scenario

Project goal

Establishment of a development process that continuously realize safer AD

- **SAKURA project activity history (2018-2025)**

👆 **UNR157**
👆 **JAMA framework (v1)**

👆 **JAMA framework (v2)**

2018 | *2019* | *2020* | *2021*

Project start-up	Proposal of C&C Driver	Scenarios for UN R157	Finalizing ISO34502

✓ Following German PEGASUS project
✓ Outcome (1st year)
  • Scenario structure in highway (32 patterns)
	✓ Proposal of JP concept
	✓ Outcome (2nd year)
	  • Defining way of foreseeability and preventability
		✓ Safety requirement and criteria for ALKS
		✓ Outcome (3rd year)
		  • Parameter ranges (Cut in, Cut out, Deceleration)
			✓ Approval of Committee Draft, Draft of IS
			✓ Outcome (4th year)
			  • Scenario expansion (LC, Merge, Branch)

● SAKURA project activity history (2018-2025)

☝ ISO34501/34502
☝ JAMA framework (v3)

☝ UNR157 (Revised)
☝ ISO34503

☝ ISO34504

☝ ISO34505
☝ JAMA framework (v4)

2022   *2023*   *2024*   *2025*

Publishing ISO34502

Best Paper Award

New UN ADS guideline

New UNR-ADS in WP29

- ✓ **Reflecting research project outcomes in ISO**
- ✓ **Outcome (5th year)**
  - • **Urban domain scenario structure (58 patterns)**

- ✓ **Prototyping SAKURA scenario DB (1st trial)**
- ✓ **Outcome (6th year)**
  - • **Pedestrian scenario structure (8 patterns)**

- ✓ **Support of JAMA framework updating**
- ✓ **Outcome (7th year)**
  - • **Parameters of pedestrian crossing scenario**

- ✓ **Joint updating JAMA framework**
- ✓ **Outcome (8th year)**
  - • **Eco-system concept for safer AD DevOps**

- **SAKURA international networking (2018-2025)**

VVM Final Event

SAE AVS

Mobility Innovation Week Japan

SURNISE Final Event

SAE ATS

ISO TC22 SC33 WG9

Exploring and deepening by international conference, and on-site investigation

● **Precious relationship establishment through SAKURA**

✓ **Europe**
- Germany
- United Kingdom
- France
- Netherlands
- EU HORIZON
  • SUNRISE
  • SYNERGIES
  • CERTAIN

✓ **Asia**
- CARATC
  Combiner
  ISO WG9

ISO3450X
TC22/SC33/WG9

UN regulations
WP29/GRVA/VMAD
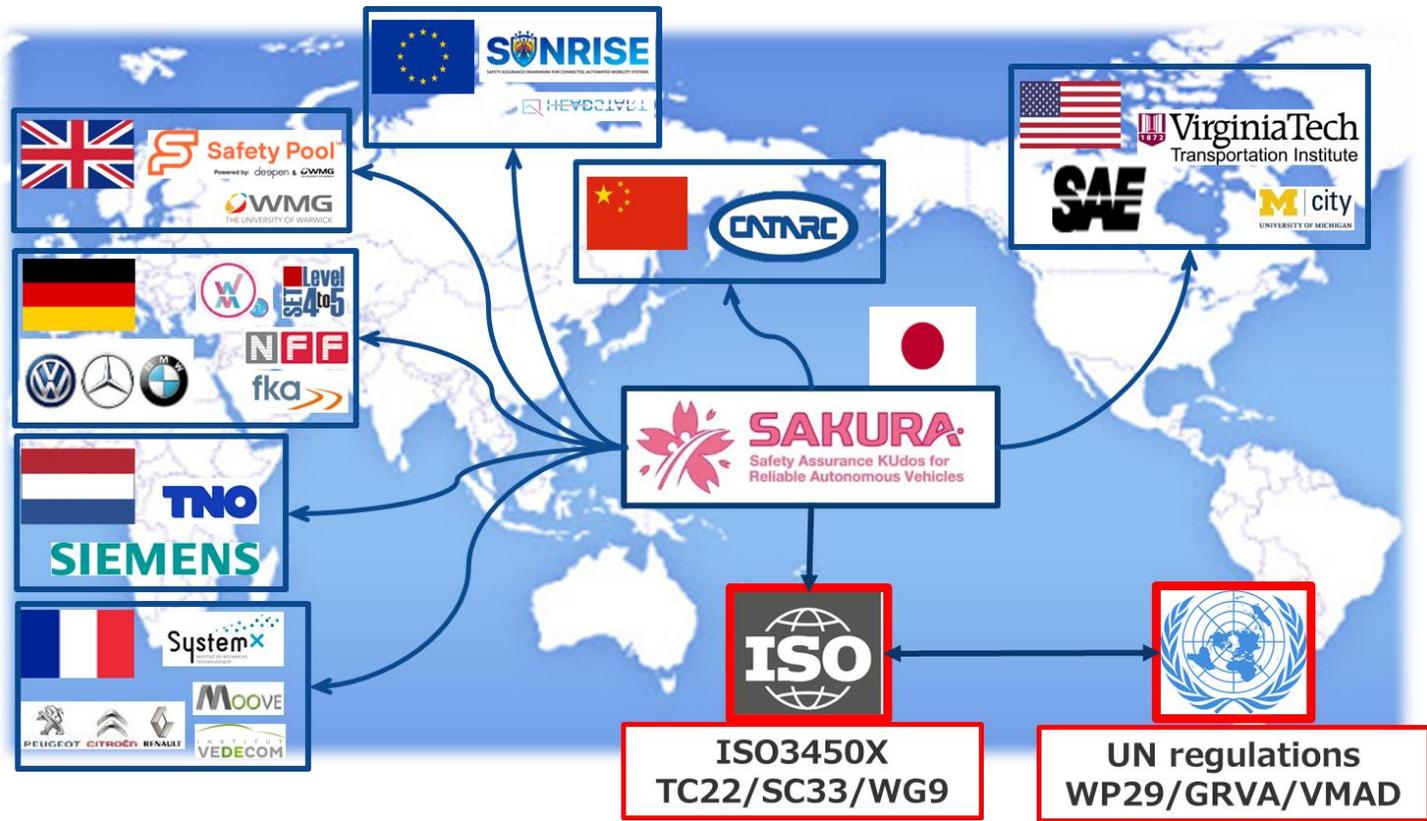
✓ **North America**
- Government
  • NHTSA
  • DOT

- Industry
  • SAE
  • AVSC
  • Waymo
  • Aurora
  • TORC
  • VTTI
  • Mcity

etc.

Information exchange and in-depth discussion for AD safety assurance

2. SAKURA project outcomes

International trends (UNECE/WP29)

UNECE/WP29

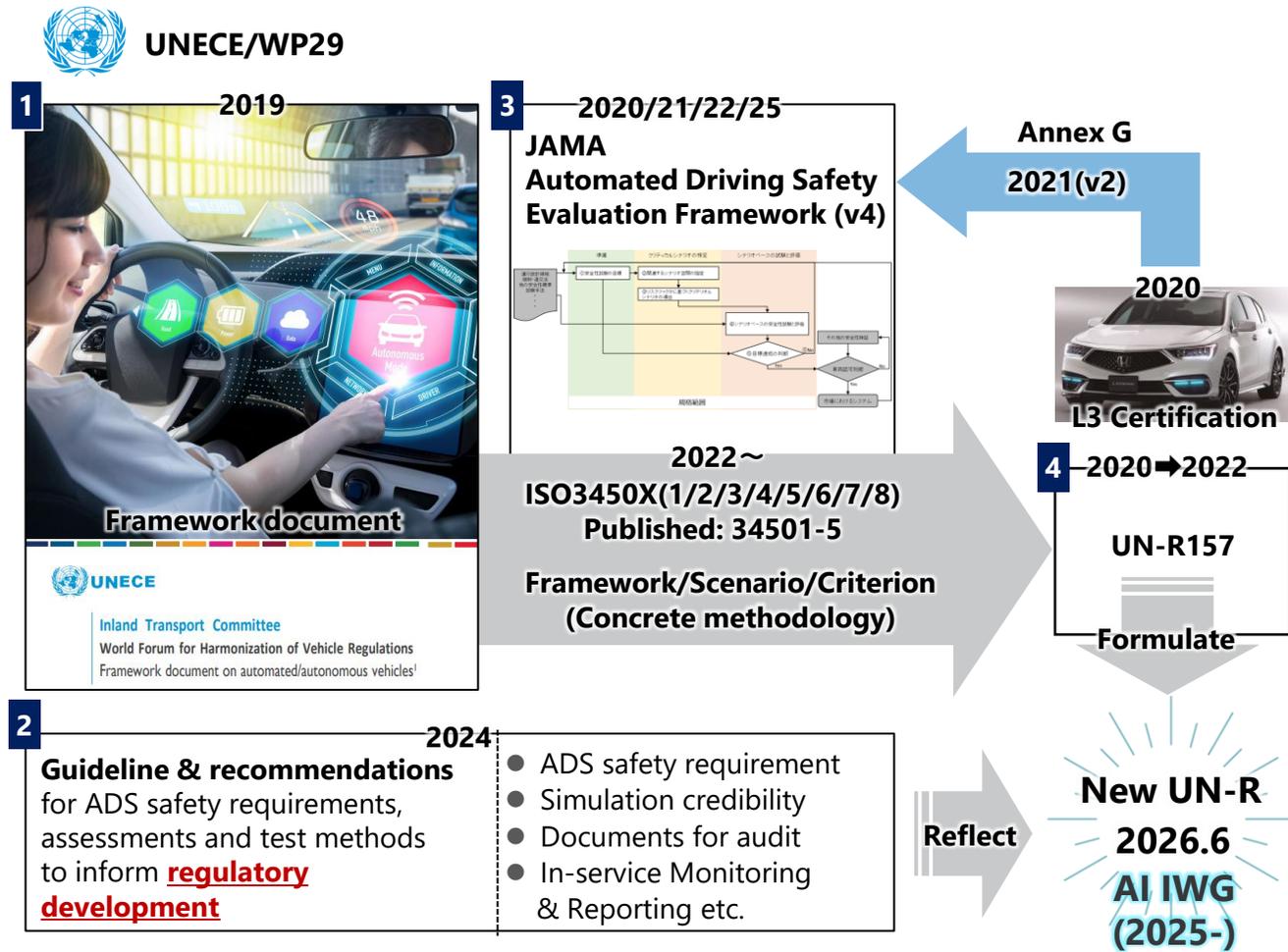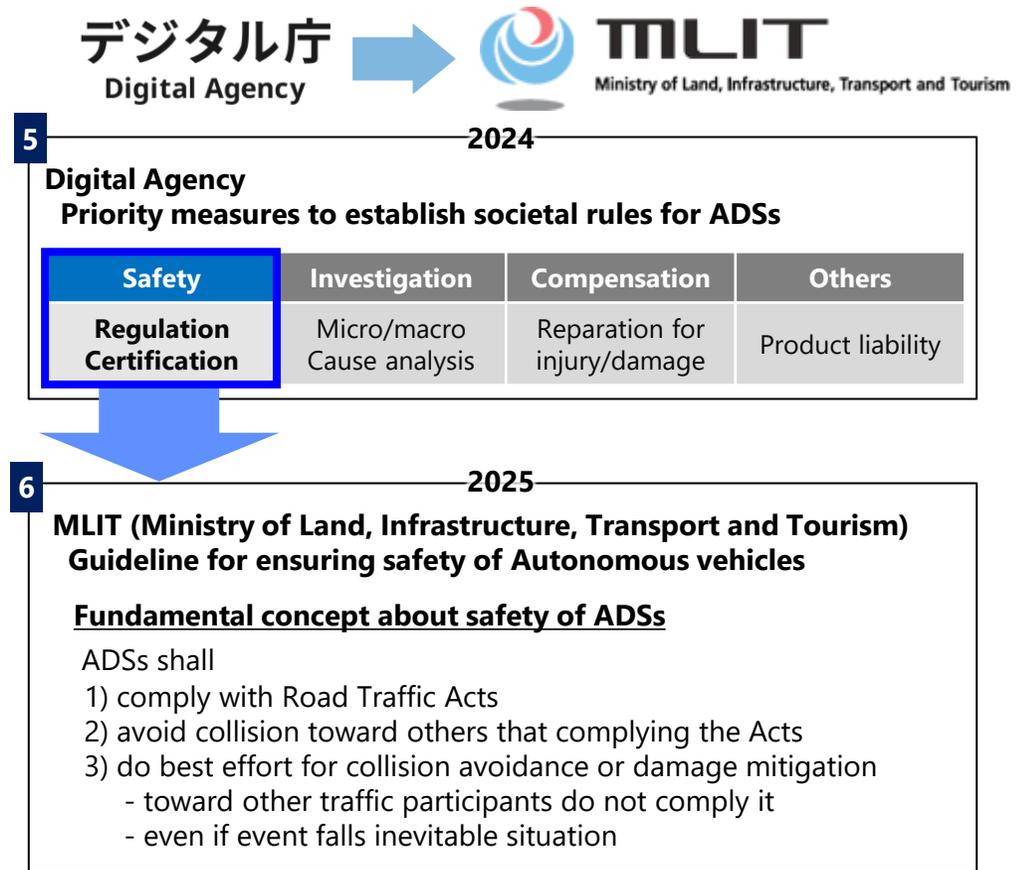**1** 2019

Framework document

UNECE
Inland Transport Committee
World Forum for Harmonization of Vehicle Regulations
Framework document on automated/autonomous vehicles

3 2020/21/22/25

JAMA
Automated Driving Safety
Evaluation Framework (v4)

2022~
ISO3450X(1/2/3/4/5/6/7/8)
Published: 34501-5

Framework/Scenario/Criterion
(Concrete methodology)

Annex G
2021(v2)

2020

L3 Certification

4 2020 ➡ 2022

UN-R157

Formulate

2 2024

Guideline & recommendations
for ADS safety requirements,
assessments and test methods
to inform **regulatory development**

- ADS safety requirement
- Simulation credibility
- Documents for audit
- In-service Monitoring & Reporting etc.

Reflect

New UN-R
2026.6
AI IWG (2025-)

Domestic trends (Digital Agency/MLIT)

デジタル庁 Digital Agency ➡ MLIT Ministry of Land, Infrastructure, Transport and Tourism

5 2024

Digital Agency
Priority measures to establish societal rules for ADSs

Safety	Investigation	Compensation	Others
Regulation Certification	Micro/macro Cause analysis	Reparation for injury/damage	Product liability

6 2025

MLIT (Ministry of Land, Infrastructure, Transport and Tourism)
Guideline for ensuring safety of Autonomous vehicles

Fundamental concept about safety of ADSs

ADSs shall
1) comply with Road Traffic Acts
2) avoid collision toward others that complying the Acts
3) do best effort for collision avoidance or damage mitigation
   - toward other traffic participants do not comply it
   - even if event falls inevitable situation

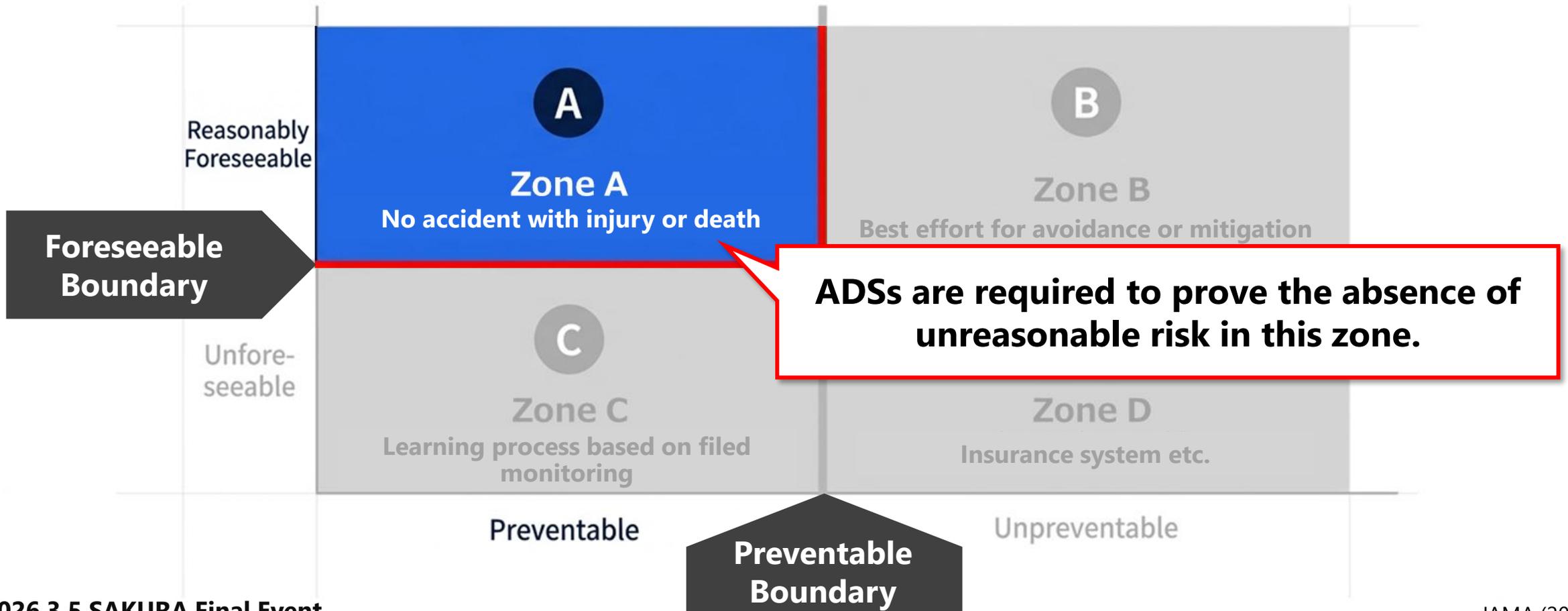**New safety requirements guidance based on relationship whether complying with Road Traffic Acts or not**

Necessary to embody plausible and desirable certification procedure

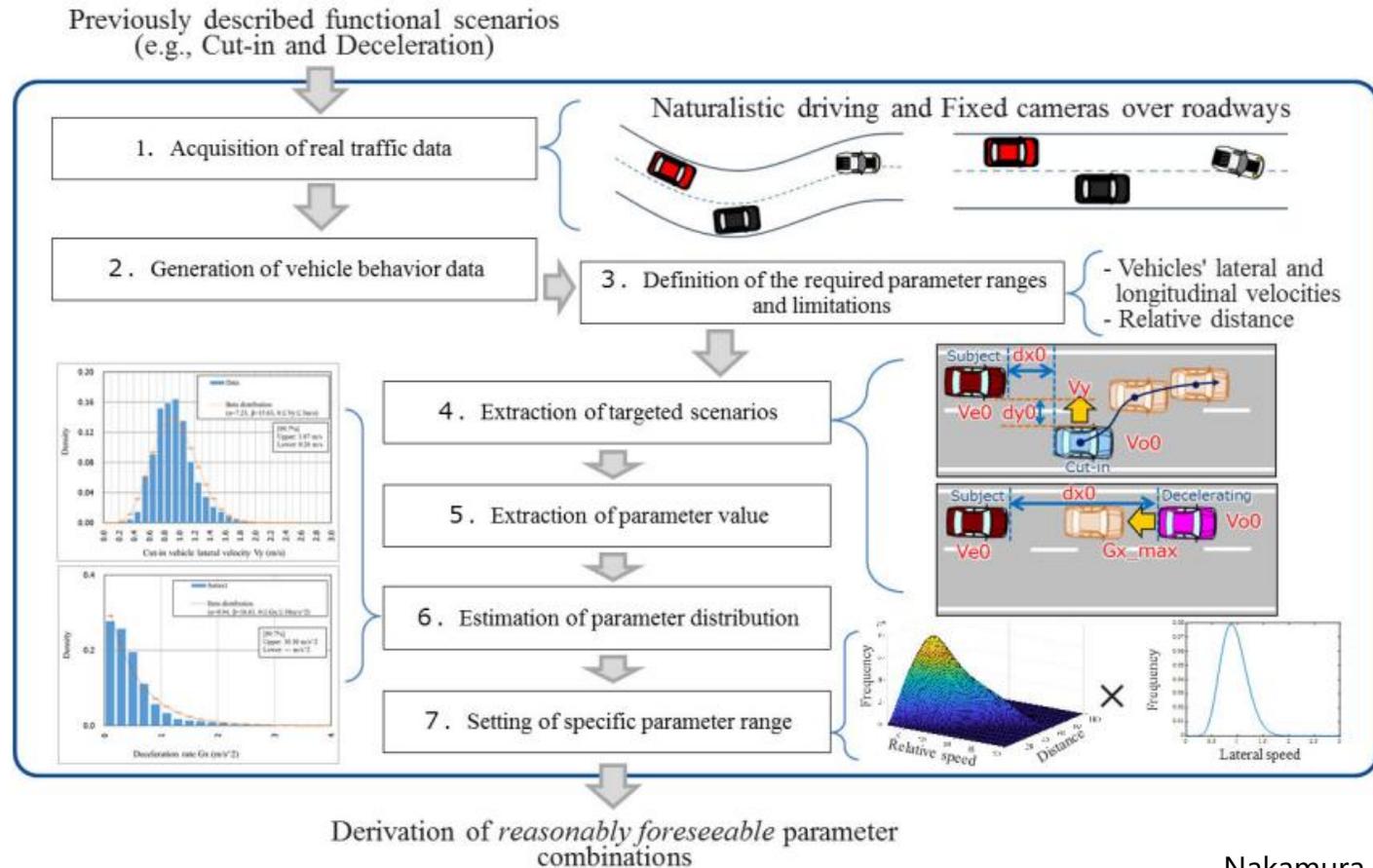● **Prevent reasonably foreseeable and preventable accident**

Automated vehicles shall not cause any non-tolerable risk, meaning that, under their operational domain, **shall not cause any traffic accidents resulting in injury or death that are reasonably foreseeable and preventable.**

UN/WP29 (2019)

Reasonably Foreseeable

A

Zone A
No accident with injury or death

B

Zone B
Best effort for avoidance or mitigation

Foreseeable Boundary

ADSs are required to prove the absence of unreasonable risk in this zone.

Unfore-seeable

C

Zone C
Learning process based on filed monitoring

Zone D
Insurance system etc.

Preventable

Preventable Boundary

Unpreventable

● **Foreseeable boundary (scenario structure/real traffic data analysis)**

Nakamura et al. (2022)

Defining reasonable foreseeability based on real traffic data analysis

● Preventable boundary (Competent & Careful Human Driver* modeling)

* A human driver who possesses the necessary skills and knowledge, complies with applicable road traffic laws, remains continuously attentive, and operates a vehicle with appropriate capability and care while maintaining awareness of surrounding traffic participants.

JAMA (2025)

【Responder】

UNR157 C&C Driver Model for ALKS

JAMA (2025)

【Initiator】

R79 equation of $S_{critical}$ to calculate

$$S_{critical} = (V_{rear} - V_{ACSF}) \cdot t_B + (V_{rear} - V_{ACSF})^2 / (2 \cdot a) + V_{ACSF} \cdot t_G$$

NTSEL (2022)

【Outcome 1】 Concept/evidence for driver model

Concept/parameter/value

【Outcome 2】 Safety requirement for ADSs

[Responder]   [Initiator]

Defining preventability by comparison with appropriate driver behavior

● **Applicable test scenarios for both real/virtual test**

✓ **Evidence of parameter range**

- **Analysis result based on actual traffic flow**
  - Validate functional scenarios
  - Estimate parameter distribution

- **Safety criterion defined by C&C driver model**
  - Preventable boundary

- **Near crash/Accident scenarios**
  - * under development

✓ **Linkage to simulation platform**

- **Output standardized format file (OpenDRIVE, OpenScenario)**
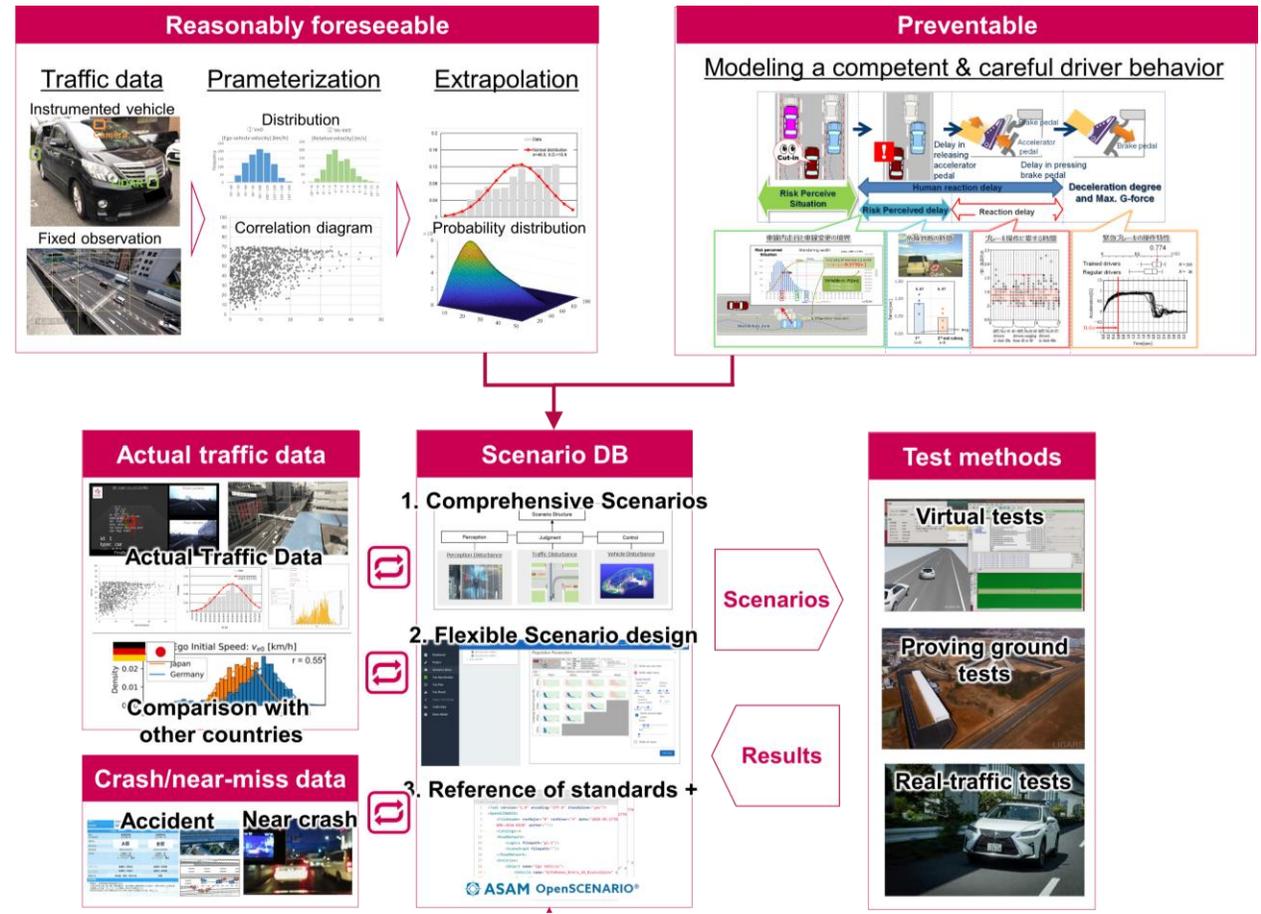
SAKURA scenario DB for safer AD development and evaluation

● Methodology and platform for practicing JAMA framework

1

• **Methodology**
• **Evidence**

to confine sufficient and necessary scenario

2

• **Test spec design**
• **Scenario DB**
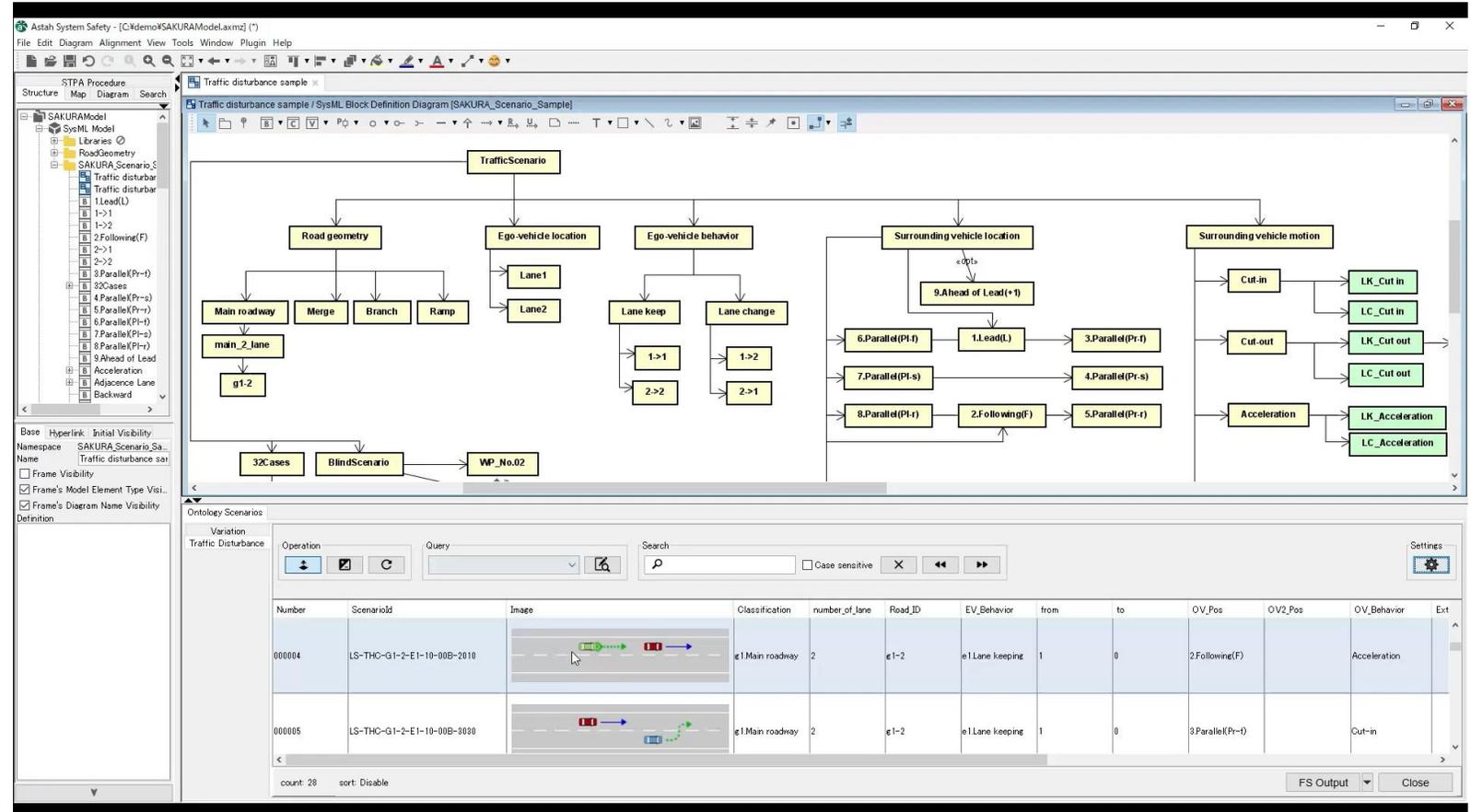
to confine sufficient and necessary scenario

Under improving

Trying to provide useful and effective platform for safety evaluation

Toward eco-system for safer AD realization

Traffic flow DB
- Measurement vehicle data
- Fixed point observation data
- Accident data
- Near crash data

Actual Data

58 patterns (Vehicle)

8 patterns (Pedestrian)

Update (regular)

Update (at any time)

DSSAD report DR ●REC ← **Collection**

search extraction

1 Continuous and regular updating test scenarios for safety evaluation

2 ADS certification / ISMR

ISMR: In-Service Monitoring and Reporting

100 places (in 2027)
50 places (in 2025)

The aim
Accelerating social implementation

Scenario Database

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scenario

1 development

OEM

1 Requirements engineering

Tier 1

2 System design

AD System

Expanded scope of application

EV model

Scenario

2 Authorization

OEM

Production / Sales → **accident Incident**

System testing **6**

Tier 1

Functional testing **5**

Tier 2 …

3 Future contribution to shorten development period of SDV

SDV: Software Defined Vehicle

3 Functional design

Tier 2 …

The aim
Accelerating SDV development

4 Unit / component design

Development

3. Concluding remarks

3. Concluding remarks

- **About SAKURA project**

  - to research methods and means for practicing JAMA Automated Driving Safety Evaluation Framework
  - to lead discussions on rule-making based on international collaboration and coordination
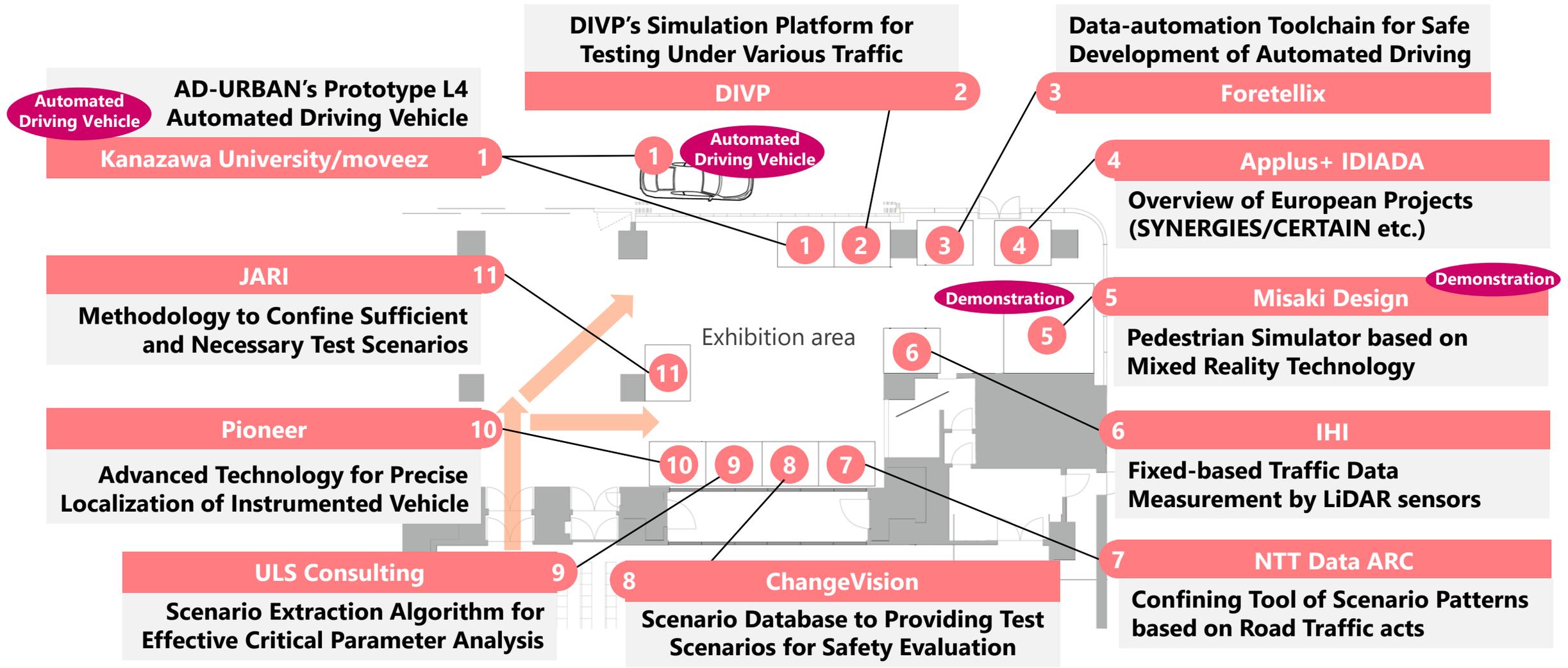
- **SAKURA project outcomes**

  1) Defining method of reasonable foreseeability and preventability
  2) Continuous input into discussions on international standards and regulation
  3) Scenario provision related to real traffic data for safety evaluation

Further establishing methodology and platform to accelerate AD development

Exhibition area

Exhibition area

- ## 11 exhibition booths

DIVP's Simulation Platform for Testing Under Various Traffic

Data-automation Toolchain for Safe Development of Automated Driving

AD-URBAN's Prototype L4 Automated Driving Vehicle

Automated Driving Vehicle

DIVP — 2

3 — **Foretellix**

Kanazawa University/moveez — 1

1 *Automated Driving Vehicle*

4 — **Applus+ IDIADA**

Overview of European Projects (SYNERGIES/CERTAIN etc.)

JARI — 11

Methodology to Confine Sufficient and Necessary Test Scenarios

Demonstration

5 — **Misaki Design** *Demonstration*

Pedestrian Simulator based on Mixed Reality Technology

Pioneer — 10

Advanced Technology for Precise Localization of Instrumented Vehicle

6 — **IHI**

Fixed-based Traffic Data Measurement by LiDAR sensors

ULS Consulting — 9

Scenario Extraction Algorithm for Effective Critical Parameter Analysis

8 — **ChangeVision**

Scenario Database to Providing Test Scenarios for Safety Evaluation

7 — **NTT Data ARC**

Confining Tool of Scenario Patterns based on Road Traffic acts

Exhibition area

Thank you for your attention.

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Safety Assurance KUdos for
Reliable Autonomous Vehicles

META
Ministry of Economy, Trade and Industry