

# Virtual validation platform development for Automated Driving Safety Assurance

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*Weather Forecast*



*AD\* safety Assurance*



*For Validation & Verification Methodology*

# Index

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- Objective & Motivation

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- Achievement

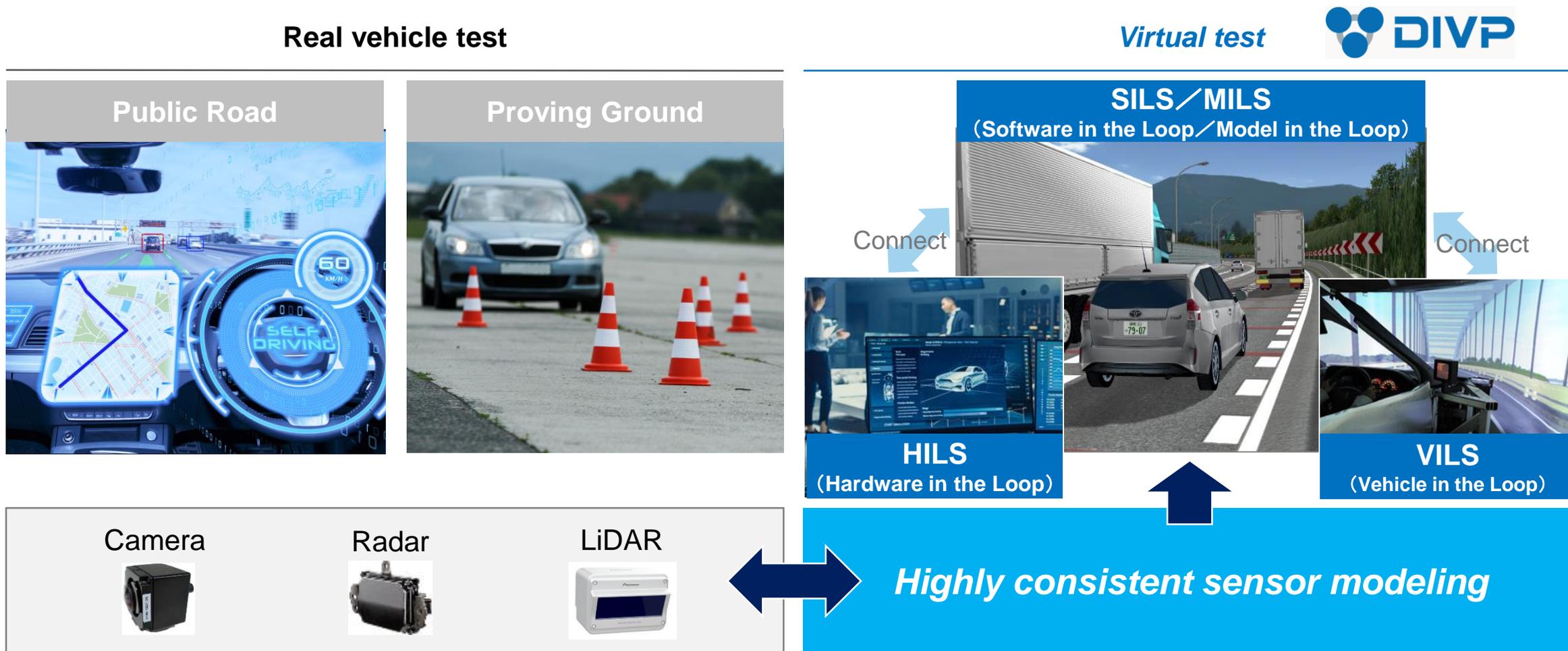
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- Summary

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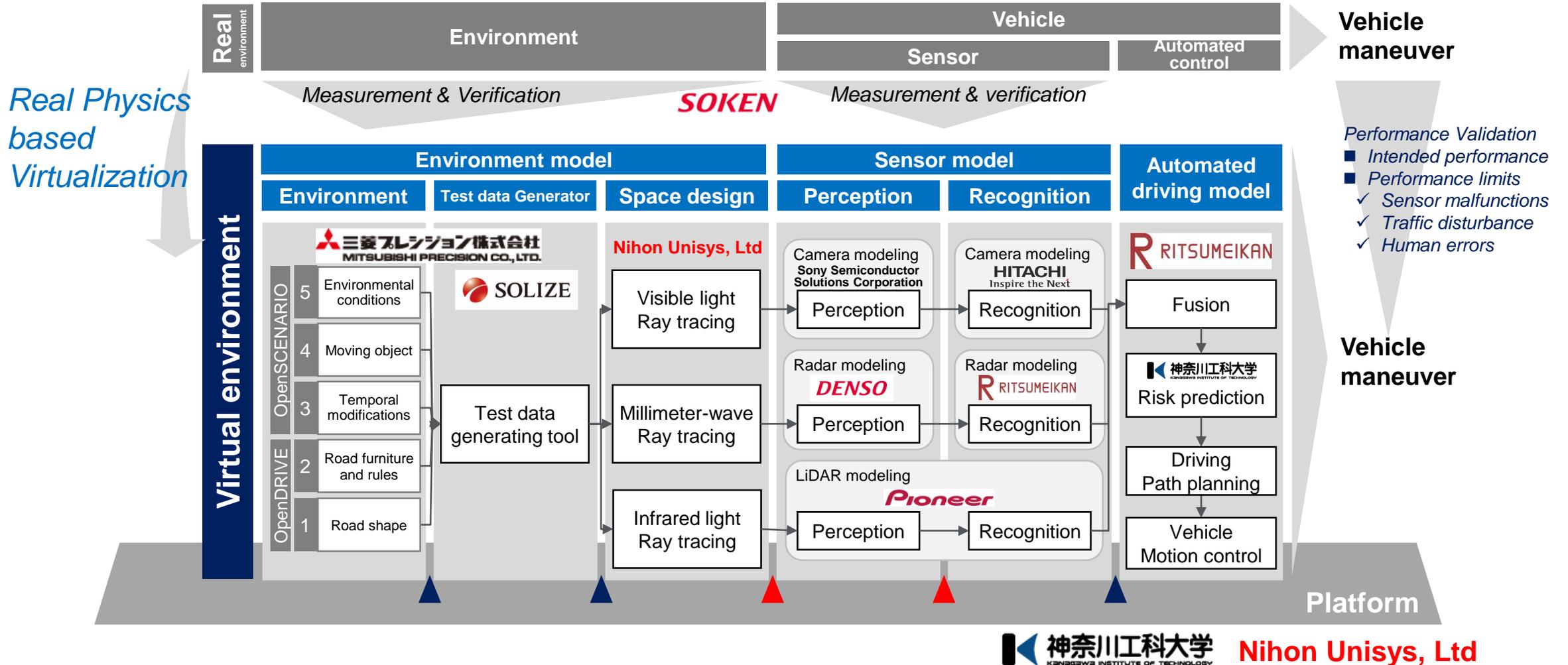
# Highly Consistent Sensor Modeling is a key enabler of virtual validation for AD/ADAS safety assurance. HCSM indicates environmental, ray trace, and sensor models.

## Motivation : Highly Consistent Sensor Modeling (HCSM)



# Designed project architecture, Precisely Duplicate from Real to Virtual, and Verification of consistency with real testing by 10-experts as DIVP® Consortium

## DIVP® project design



# Achievement

- **Highly consistent sensor modeling**
- Validation expansion on virtual community ground

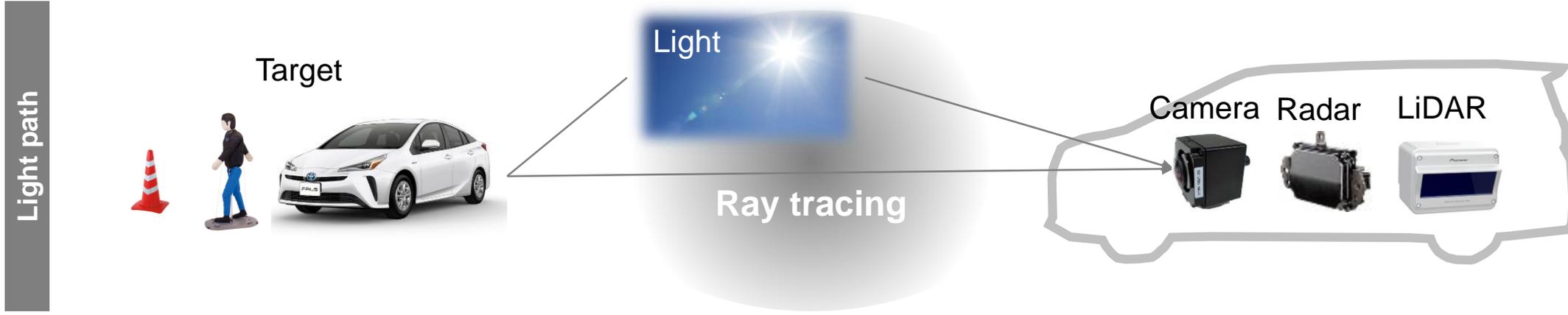
# Investigated model units and Interfaces based on light path from source to sensor output, and defined Environmental, space design and Sensor perception & recognition models

## Example Camera modeling

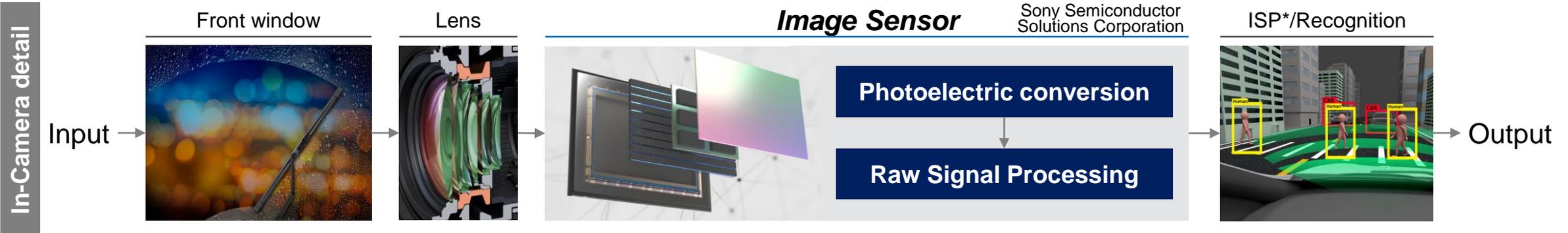
HITACHI  
Inspire the Next

Sony Semiconductor  
Solutions Corporation

DENSO SOKEN Pioneer



*Next Step is to Virtualize Image sensor for precise Perception*



\* Image Signal Processor  
Source : SOKEN, INC, Sony Semiconductor Solutions Corporation  
DIVP® Consortium

**20% deviation on Camera output Real to Virtual. This is similar to the actual Camera tolerances, meaning that this is capable as a sensor validation method.**

**Camera Consistency verification result\***

Sony Semiconductor  
Solutions Corporation

Real test result



SIM result (Clear sky)



*Brightness level is similar*

\* 8bit in 24bit

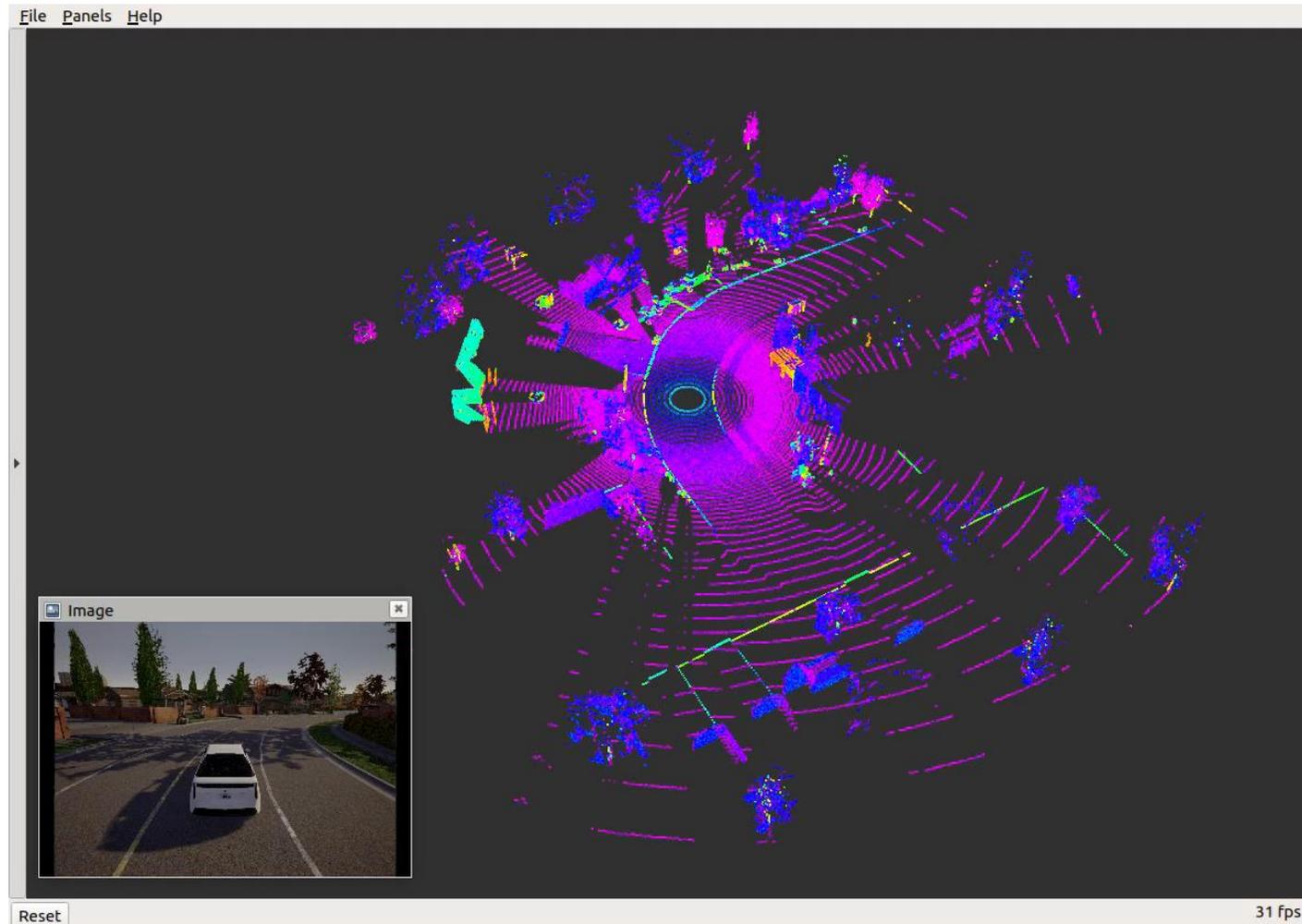
Source : Sony Semiconductor Solutions Corporation, SOKEN, INC

DIVP® Consortium

# LiDAR modeling & verification was implemented

## LiDAR simulation

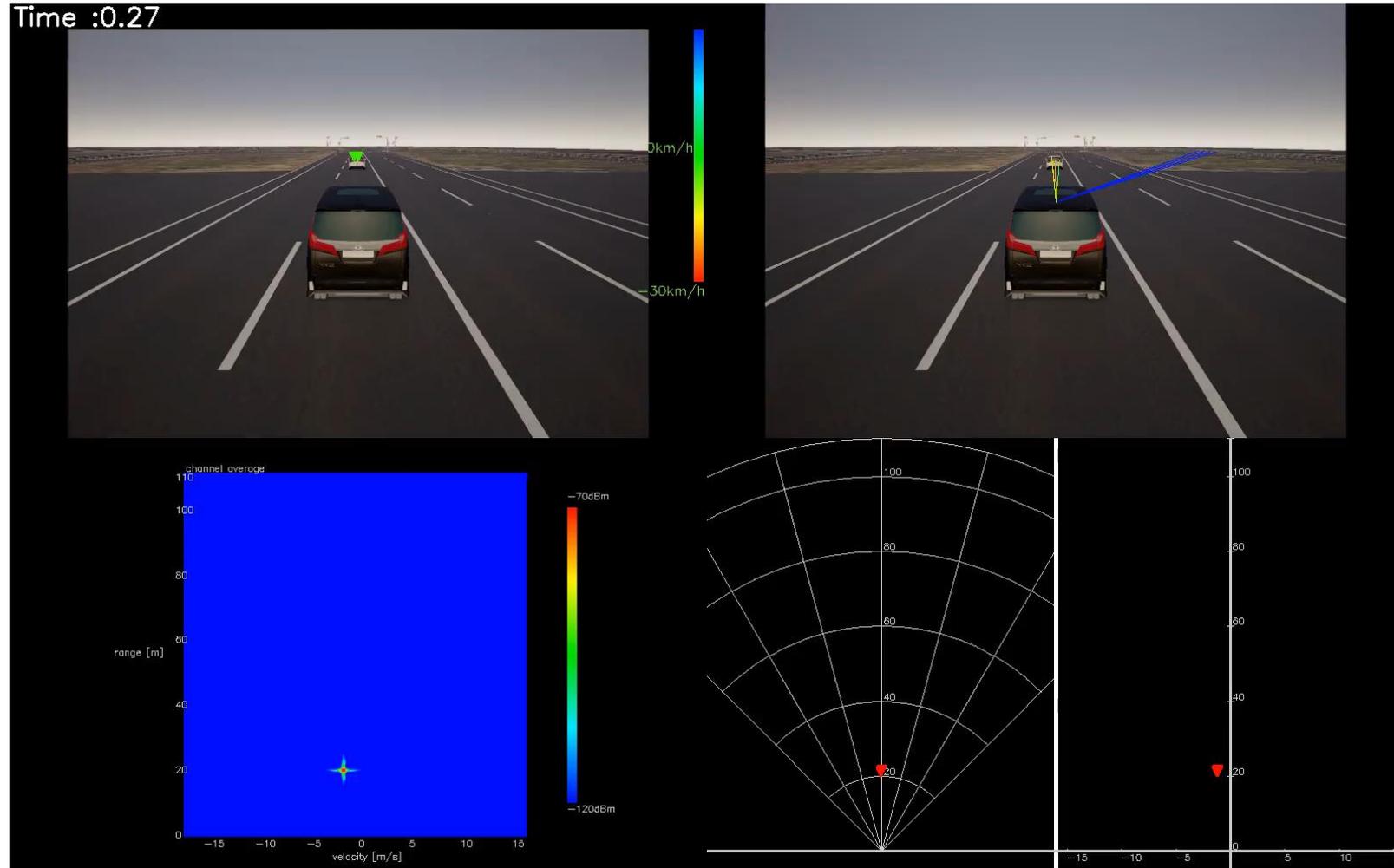
Nihon Unisys, Ltd



# Radar model was implemented & under validation of Real vs Simulation consistency

## Radar simulation

**DENSO SOKEN** Nihon Unisys, Ltd



# Application “Property” onto model surfaces realize precise objects in virtual environment

## Properties

Nihon Unisys, Ltd **SOKEN**  三菱プレシジョン株式会社  
MITSUBISHI PRECISION CO., LTD.

### No Property

The result is flat with no color or texture.



### With Property

The characteristics of the material are reproduced, and the strength and transparency of color and reflection can be reproduced.



# Close Multi objects correctly detected object by object with High resolution Radar

## Example of Radar performance evaluation



Low resolution



High resolution



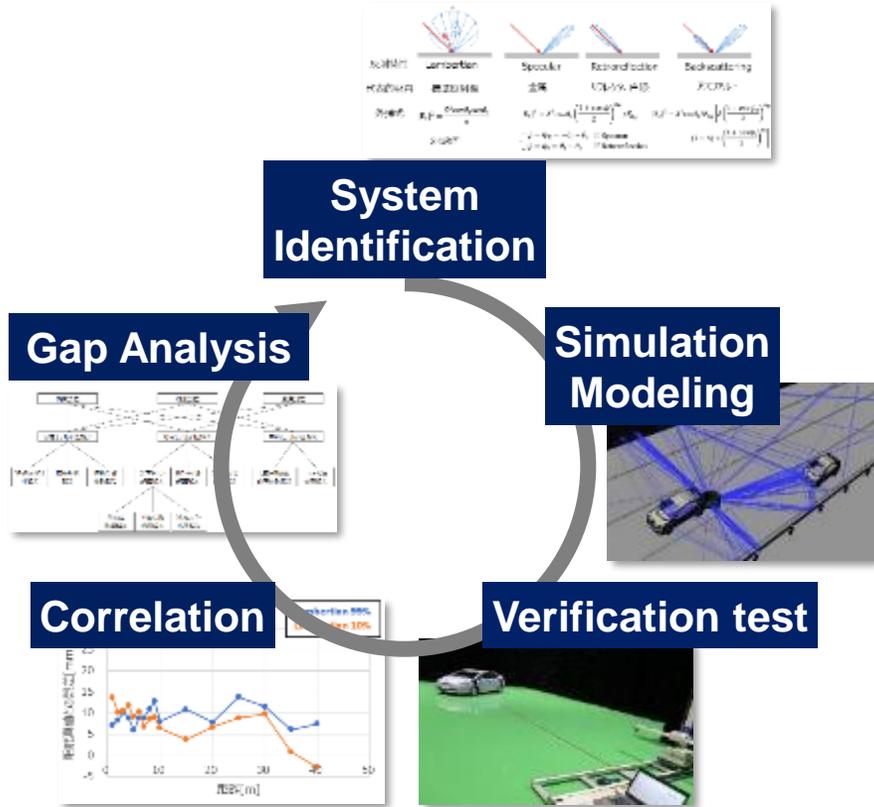
# Achievement

- Highly consistent sensor modeling
- **Validation expansion on virtual community ground**

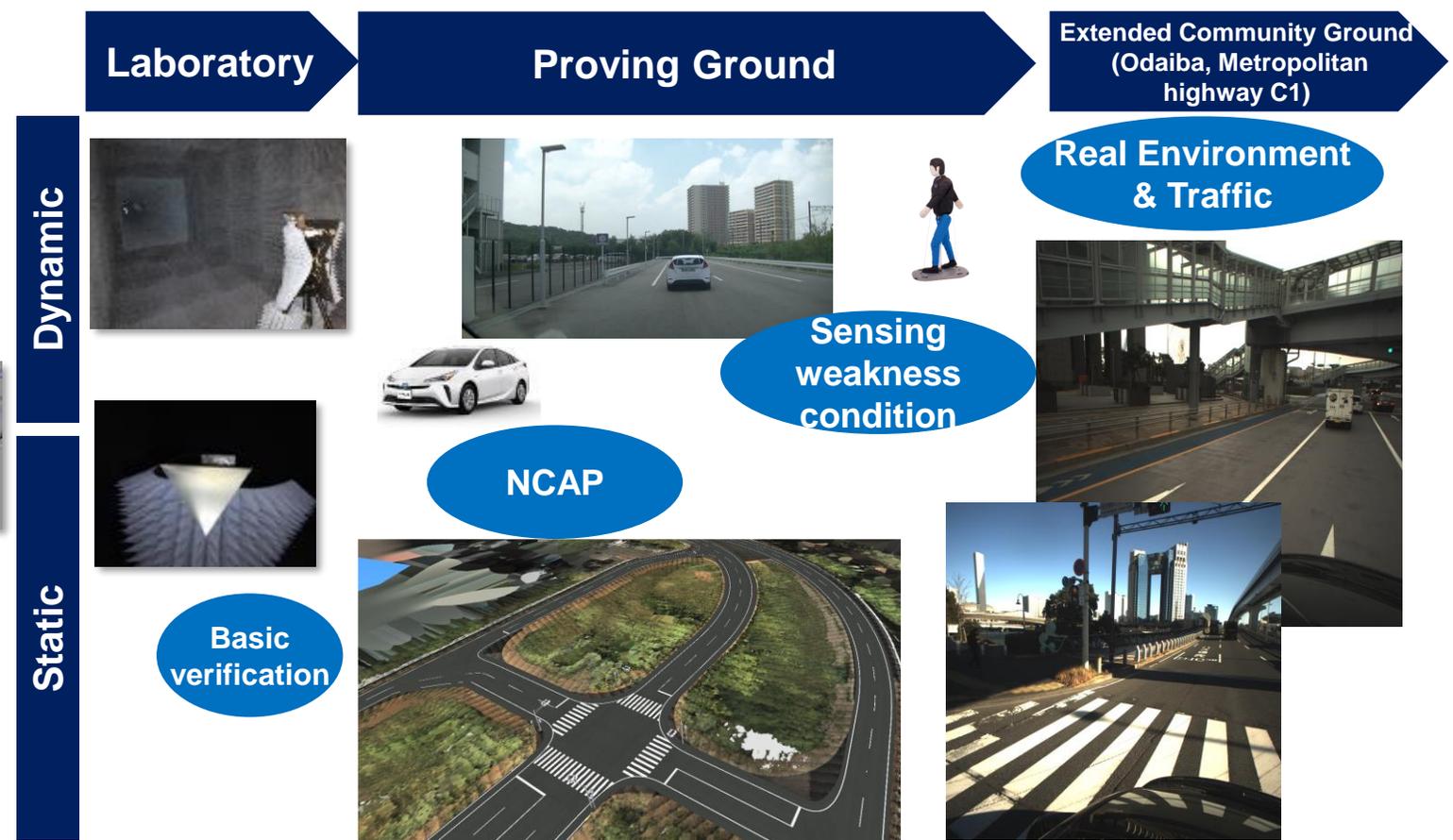
# With PDCA modeling & validation testing, DIVP<sup>®</sup> duplicate Virtual-PG/CG capable for some NCAP protocols and sensing weakness condition

## Measuring based Modeling framework

Measurement based approach



Enhancement roadmap



# DIVP<sup>®</sup> focusing on making the simulation capable for sensing weakness validation and construct Virtual-PG/CG for AD-Safety assurance

## Sensing domain based approach

Difficult for detection

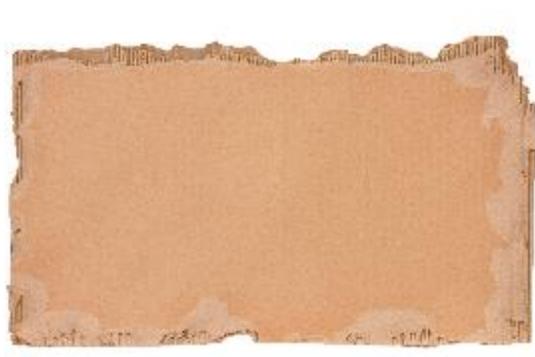
Black jacket



Group moving objects



Cardboard



Wet surface



Affects for light / millimeter wave propagation

Night



Millimeter wave Multi-path



Rain



Sunlight, Backlight



# Virtual-PG realize Euro-NCAP and continuous expansion toward 2025

## Euro-NCAP Simulation ; pedestrian darting out scenario

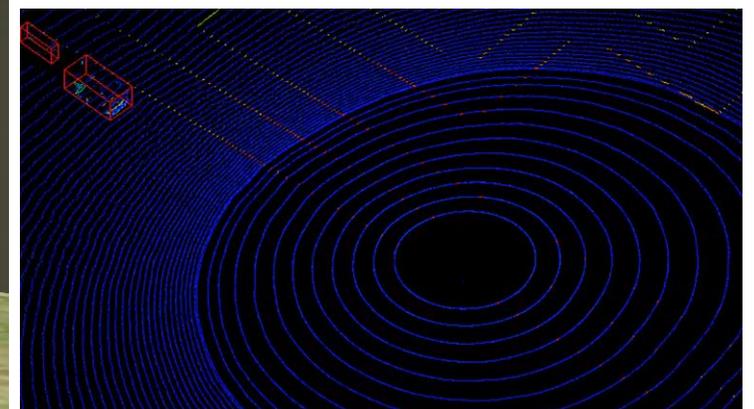
Pedestrian darting out scenario sim.



Camera sim.



LiDAR sim.



It is possible to assemble any traffic environment such as road shape, placement of traffic participants, movement setting and also environmental factors such as rain and backlight.

## Building Virtual Proving Ground

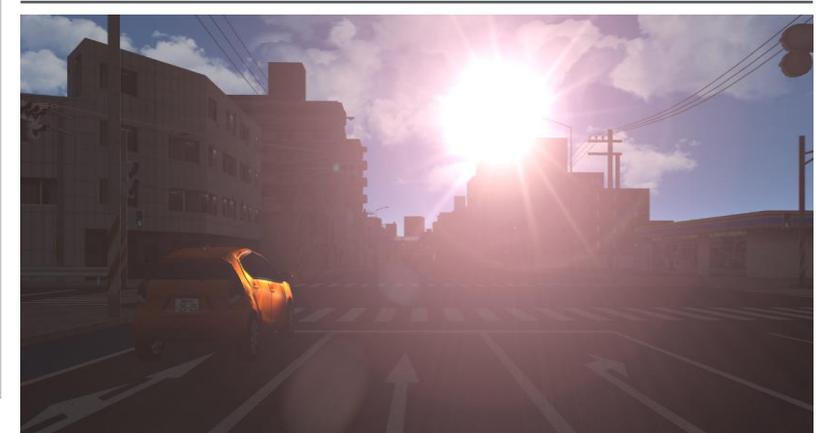


Simulation of traffic environment at J-town intersection

Rain



Backlight



# For the sensing weakness validation in Real situation construction Odaiba Community Ground and contribute to AD safety assurance

## Odaiba Virtual Community Ground



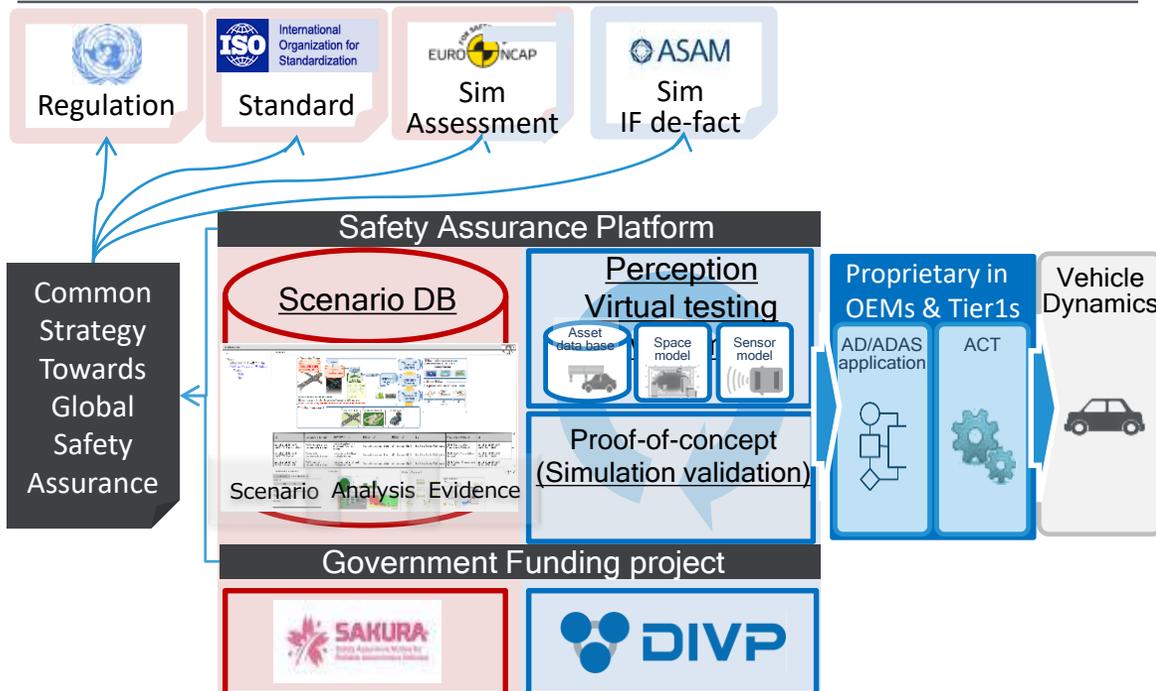
\* The video is under development and may differ from the actual specifications.  
Source : MITSUBISHI PRECISION CO.,LTD.

# Summary

# Summary

- DIVP® in SIP-adus believes that sensing domain based approach leads AD/ADAS to safer mobility society.
- DIVP® in SIP-adus will contribute to the standardization of I/F, reference modeling procedure with respective global activities.

## Position in AD-safety assurance



## DIVP® Objectives

- *Open Standard Interface*
- *Reference platform with reasonable verification level*
- *E & S pair model based approach (E : Environmental model, S : Sensor model)*

**END**

*Tokyo Odaiba FOT area → Virtual Proving Community Ground*

