Application Guidelines for Participating in the Tokyo Waterfront City Area Field Operational Test (simulation-based experience) for Strategic Innovation Promotion Program (SIP) Phase Two - Automated Driving (Expansion of Systems and Services) (Building a safety evaluation environment in Virtual Space)

1 Background 2
2 Purpose 3
3 Operation Summary 4
3.1 Summary of the Field Operational Test （Simulation-based Demonstration Experiment） 4
3.2 Simulation-based Demonstration Experiment Period 5
3.3 Simulation-based Demonstration Experiment Period 6
3.4 Operetion Contents 6
3.4.1. Virtual environments that participants can use as the base environments... 6
3.4.2. Outputs (interfaces) that Participants can Use 8
3.5 Our Request for Participants 8
3.6 Operation and Management Organigram 9
4 Participation Requirements and Selection 9
4.1 Requirements for Participants 9
4.2 Application Procedure and Flow of Examination 10
4.3 Application 10
4.4 Notes to the Application 11
4.5 Selection of Participants 11
4.6 Application Period 11
4.7 Notification 12
(Attachment) Strategic Innovation Promotion Program (SIP) Phase Two - Automated Driving (Expansion of Systems and Services) (Building a safety evaluation environment in Virtual Space) 13

1 Background

Through the “Strategic Innovation Promotion Program (SIP) Phase Two - Automated Driving (Expansion of Systems and Services) (Building a safety evaluation environment in Virtual Space)”, we are developing a safety validation platform in a virtual space featured by a series of "driving environment objects – electromagnetic wave propagations - sensors" models simulating real phenomena highly faithfully that could substitute for evaluation experiments in actual environments. (Fig. 1).

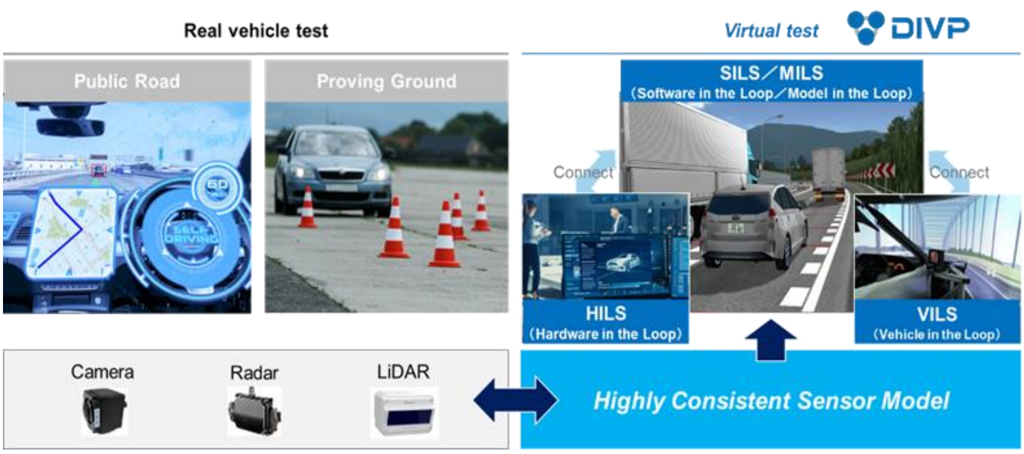


Fig. 1 Features of DIVP®: Sensor modeling that highly faithfully replicates actual phenomena

Also, we of the DIVP® Consortium have worked on creating a simulation environment for verifying safe autonomous driving in cooperation with Japan Automobile Manufacturers Association, Inc. (JAMA).
We have enhanced the DIVP® simulation capabilities by digitally incorporating ALKS cut-in scenarios proposed at the SAKURA project of JAMA and the Japan Automobile Research Institute (JARI) as well as NCAP assessment scenarios in addition to our scenarios focusing on uncovering sensor weakness in the Tokyo Waterfront Area (Odaiba)mimic environment. We will contribute to safety validation of autonomous driving in response to needs from users of the auto industry such as original equipment manufacturers (OEMs) and suppliers.

We developed a virtual environment that mimics the Tokyo Waterfront area. The area is the location for the field operational test (simulation-based demonstration experiment) for Strategic Innovation Promotion Program (SIP) - Automated Driving.

Our DIVP® simulation platform can easily enhance system verification patterns by assigning virtual environmental factors to various evaluation scenarios. The platform can identify sensor weaknesses revealed through putting into place the enhanced virtual scenarios. The DIVP® platform thus enables efficient verification of autonomous driving systems.

Fig. 2 Tokyo Waterfront Area (virtual) in a virtual space

2 Purpose

In this simulation-based demonstration experiment, we will run simulations of actual phenomena in the Tokyo Waterfront area on the state-of-the-art DIVP® simulation platform. We have developed virtual models that can reflect specific requests from simulation users.

Our aim is to verify the functionality and usability of the Platform, the interface, and the real-virtual consistency indicated in simulation results delivered from the Platform that mimic actual phenomena. We would like to recruit participants in this field operational test (simulation-based demonstration experiment) who check the Platform capabilities and give us feedbacks to help us enable further developments and improvements of the Platform in the future.

Participants will be the first DIVP® user in getting touch with the cutting-edge simulation functions of DVIP platform. Also, they can know the most updated deliverables about safety evaluations such as simulation scenarios and models that we created in cooperation with JAMA and the SAKURA project.

We will prioritize feedbacks from participants in developing and improving functions for the Platform in the future.

3 Operation Summary

3.1 Summary of the Field Operational Test (Simulation-based Demonstration Experiment)

The DIVP® Consortium now develops and improves interfaces for the DIVP® Platform to accept seamlessly users' simulation data of scenarios, environments and models that they use in the research on automated driving. Participants can use their sets of simulation data on the DIVP® Platform until they know fully the fidelity of DIVP®-delivered mimics of actual sensor performances (Fig.3).

The Consortium aims to specifically develop scenarios fit for OpenSCENARIO® and OpenDRIVE® as well as interfaces in the system environment and Open Simulation Interface (OSI) (ASAM standard) complying with FMI/FMU.

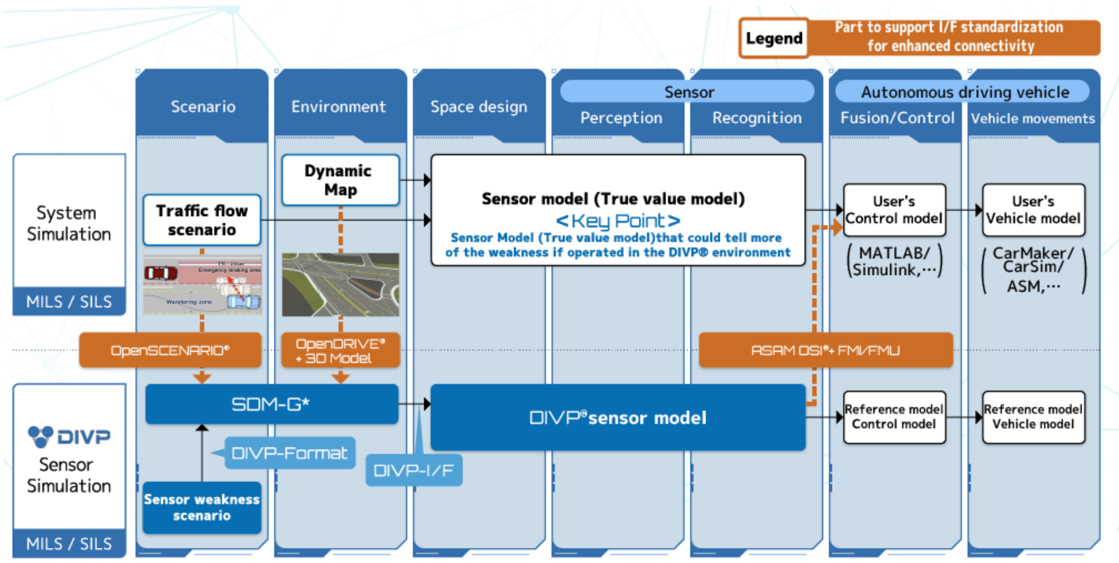


Fig. 3 Ensuring the simulation interfaces through OpenX and ASAM OSI

We would like to enable a PoC environment where specific requests from using the DIVP® platform are reflected. For this, use of the interfaces is the key. There are two key points below.

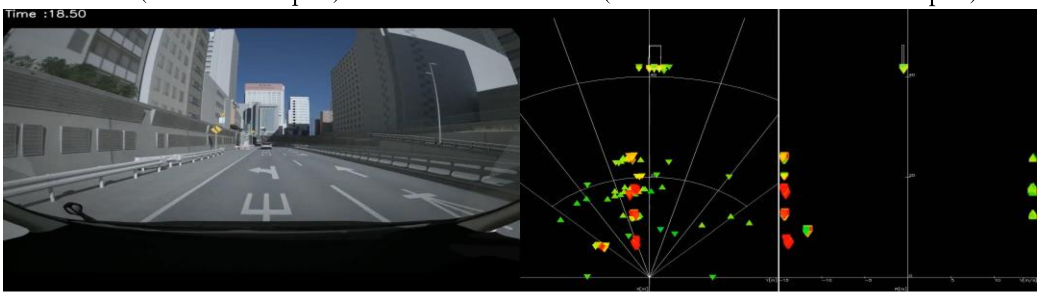
① Participants can tweak as they need simulation scenarios and environments in a virtual environment created upon the DIVP® Platform. Participants can import their data of scenario and environment in the format of FBX, OpenSCENARIO®

or OpenDRIVE®.

② Participants can feed into their models and systems (via file transfer) simulation deliverables from the DIVP® simulation platform processing a model composed of driving environment objects, electromagnetic wave propagations and sensors. (Fig. 4: camera, millimeter wave radar, LiDAR)

Participants can use the DIVP® Platform (prototype). The executive secretariat (Nihon Unisys as entrusted) will prepare for Step 1 and Step 2 above after surveying participants' needs. The secretariat will hold meetings with participants as needed. Participants are kindly requested to participate in the meetings and confirm their scenarios, environments, models, and systems.
Participants may be asked to change or adjust their own models by themselves in order to enable Step 2.

(Camera output) (Millimeter wave radar output)



(LiDAR output)

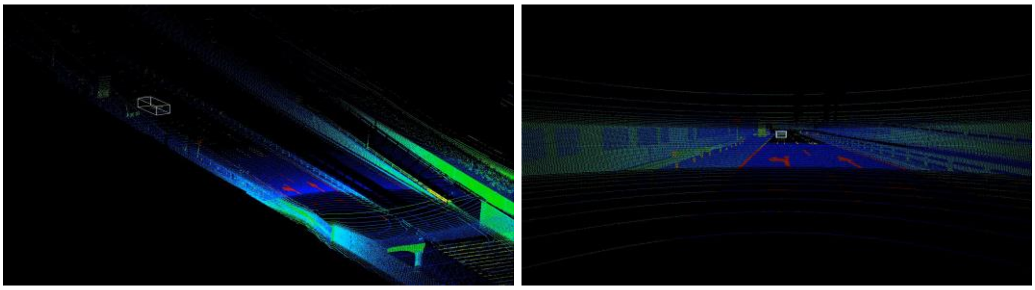


Fig 4. Edobashi JCT from CI Hamazakibashi replicated by the Simulator

3.2 Simulation-based Demonstration Experiment Period

Simulation-based Demonstration Experiment Period
From January 20, 2022 to April 28, 2022
(See the summary of activities below)

3.3 Simulation-based Demonstration Experiment Period

Participants shall be either of automobile manufacturers, suppliers, vendors of related systems and tools, institutions such as universities, research institutions or certification organizations, at home and abroad, involved in research and development of automated driving technologies

(*) Resources (devices and the executive secretariat personnel) for the experiment preparation and implementation are limited. We will accept about five participants.

3.4 Operetion Contents

3.4.1. Virtual environments that participants can use as the base environments

We have prepared the virtual environments below predicated upon actual measurements for this demonstration experiment. These two virtual environments can be used as the base environments.

(1) NCAP environment (Fig.5)

(2) Tokyo Waterfront area (Odaiba) and Inner Circular Route C1 environment (Fig. 6 and Fig.7)

Participants can easily enhance system verification patterns by assigning various types of environmental factors to evaluation scenarios. They can evaluate automated driving systems efficiently. See below the summary of virtual environments (Table1).

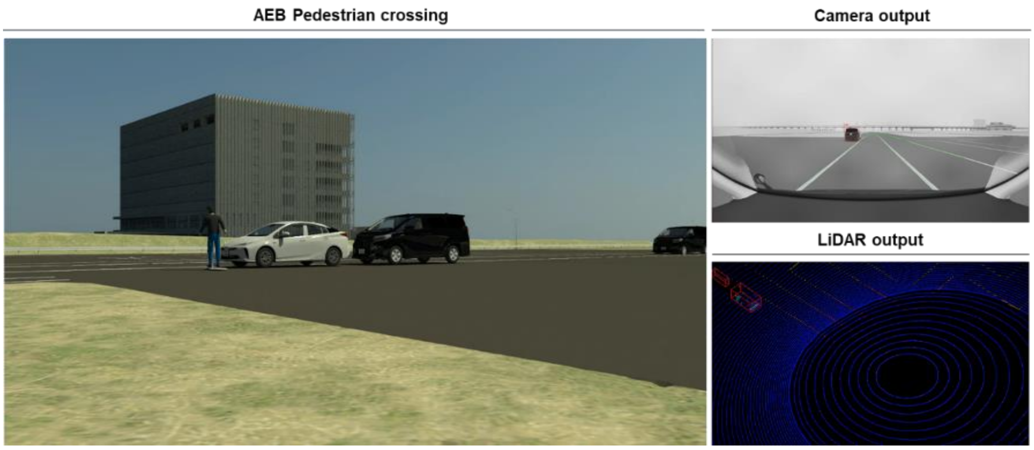


Fig.5 NCAP Scenario of a Pedestrian Crossing

Fig. 6 Odaiba station area

Fig. 7 Inner Circular Route C1 Tunnel

Table 1　Relivable Sensor Models and Packaged Scenarios (Planned)

Verified Sensor Models	■Camera　1 model ■Millimeter-wave radar 1model ■LiDAR 2models

Types	Contents of Packaged Scenarios
Assessment scenario	•Equivalent to JNCAP CPNC-50 (Pedestrian crossing behind a vehicle) ○ Sim type : Closed Loop ○ Vehicle speed : 25km/h •ALKS: Preceding Vehicle Cut-In ○ Sim type : Closed Loop ○ Vehicle speed :（self）40km/h、（preceding）20km/h
Scenario of actual environment	•Tokyo Waterfront City area（Odaiba） ○ Sim type : Open Loop ○ Camera ▪Recognition error in the shade of a tree ▪Reproduced light-distribution properties of a traffic light ○ Millimeter wave radar ▪Faded/cluttered on a road surface ○ LiDAR ▪Pedestrian of a black-dyed leather wear coming out of nowhere ▪Travelling on a road painted with a thermal barrier

3.4.2. Outputs (interfaces) that Participants can Use

Participants can obtain simulation outputs at each interface of [1] space design output, [2] perception output, and [3] recognition output, and they can use output results in units of sensor for camera, millimeter wave radar and LiDAR (via file transfer), as indicated in Fig. 8.

For example, in a case of camera, a [2] perception output can be exported in the format of RAW image. It can be fed into participants' camera recognition models. In a case of millimeter wave radar, a [1] space design output in the format of electromagnetic wave propagation can be fed into participants' millimeter wave perception/recognition models.

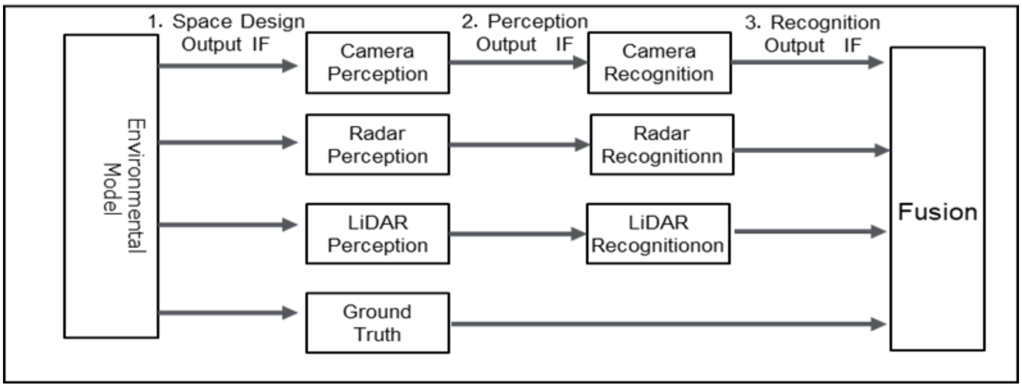


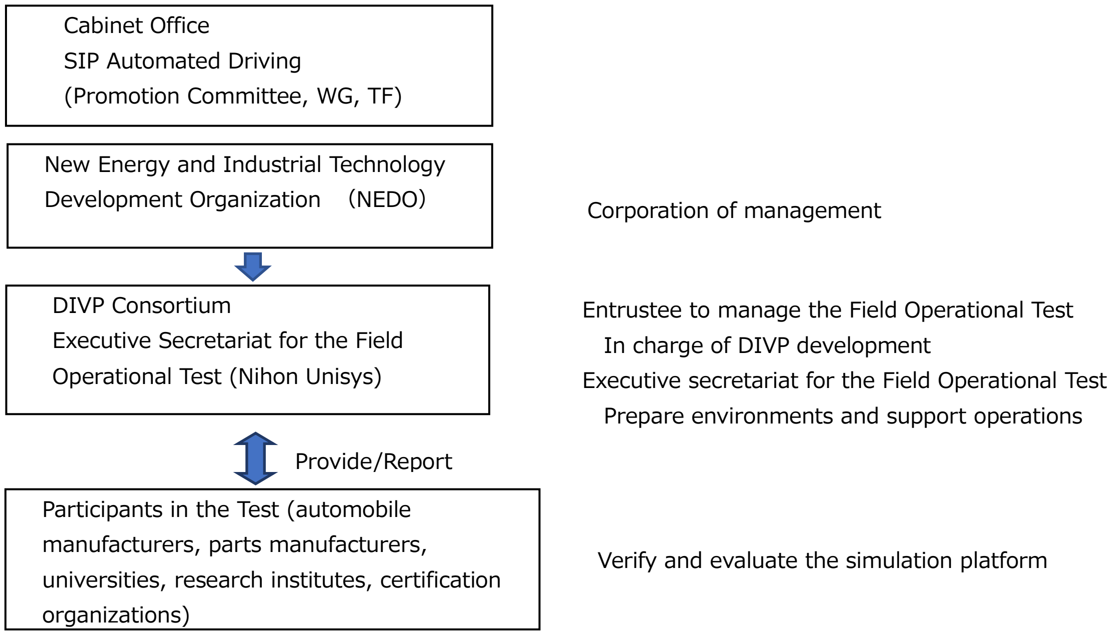
Fig. 8 Output Interfaces

3.5 Our Request for Participants

We have prepared standard scenarios and environments in our virtual space created upon the DIVP® Platform. We will import users' simulation model data into the Platform, tweak and condition the standard scenarios as requested by users and put into place the scenarios on the most up-to-dated simulation platform. We will send back simulation deliverables to users. Users will receive the deliverables through system interfaces with our platform. Users will check the functionality and usability of our simulation Platform, the interface performance, the real-virtual consistency of delivered mimics in comparison with actual environmental factors. They are kindly requested to feedback their opinions. We of the DIVP® Consortium would like to use their inputs for promoting our DIVP® research and development initiatives.

3.6 Operation and Management Organigram

Please find below our operation and management organigram.



4 Participation Requirements and Selection

4.1 Requirements for Participants

1) A participant has a legal personality predicated upon articles of incorporation that indicates the name of representative and business activities.

2) A participant has obtained experience in development and capability evaluation based upon simulation, or is considering the use of simulation, through taking part in research and development as well as evaluation of automated vehicles and related systems.

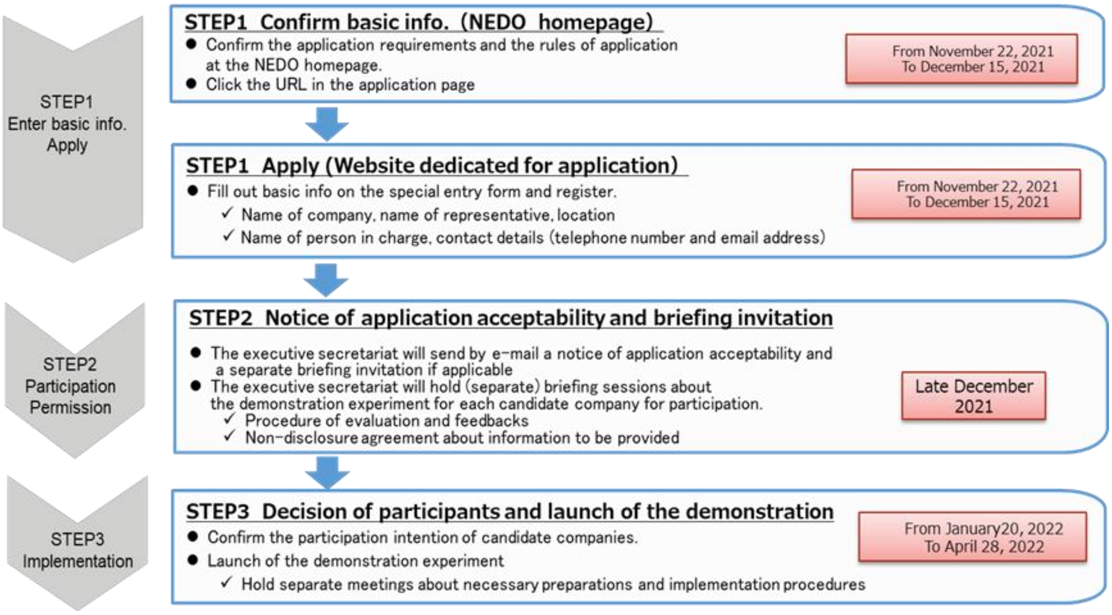
3) A participant can execute the “Non-disclosure Agreement” (separately described and provided) for the purpose of protecting information to be provided as confidential information.

4.2 Application Procedure and Flow of Examination

1)Fill out basic information on a specific form (at a portal site established for the dedicated use)

2)NEDO and the DIVP® Consortium will examine and advise participants of screening results.

3) Participants will be decided after confirming the participation intention through separate meetings. The demonstration experiment will begin.



4.3 Application

Fill out an entry form for participating in the Field Operational Test

<Basic Information>

-Company name, name of representative, location

-Name of person in charge, contact information
(telephone number, email address)

-Confirm the contents stipulated in the Rules for Participation
(In an event where personal information obtained for enabling seamless communication of information about the demonstration experiment is used for any other purposes, the person shall be informed of the use and requested for consent in advance.)

4.4 Notes to the Application

1） An application may not be accepted if made in an incomplete form.
2） NEDO and the DIVP® Consortium will select applicants pursuant to the "Key Points for Selection" as indicated in 4.5 in the event where we receive a large number of applicants. We will not respond to any inquiries regarding the selection.

4.5 Selection of Participants

We have established the selection standards below conducive to the purpose of recruitment

"Key Points for Selection"
A successful applicant:
1） takes part in implementing in society and practicalizing autonomous driving systems.
2） has had excellent technologies and track records about evaluating performances of on-board sensors for autonomous driving system
  ・with knowledge and expertise about scenes where performances of on-board sensors (for camera, millimeter wave radar, and LiDAR) should be evaluated, and evaluation standards
  ・with knowledge and expertise about implementing sensor evaluations as part of vehicle safety evaluation
3） has had evaluation implementation arrangements and information management arrangements
4） can understand that the participation status may be limited due to requests from the corporation of management and uncontrollable circumstances that may arise in the experiment operations, even if the conditions of 1, 2 and 3 above are satisfied.

4.6 Application Period

Monday, November 22, 2021: The recruitment begins
Wednesday, December 15, 2021: The recruitment ends

4.7　Notification

Applicants will be notified of screening results in the middle or the latter half of December 2021. Applicants will receive a screening result at the e-mail address that they indicated in the application form.

＜For Inquiries＞

Executive Secretariat for the “Tokyo Waterfront City Area Field Operational Test (simulation-based demonstration experiment) “ (Strategic Innovation Promotion Program (SIP) Phase Two - Automated Driving (Expansion of Systems and Services) (Building a safety evaluation environment in Virtual Space)

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(Attachment) Strategic Innovation Promotion Program (SIP) Phase Two - Automated Driving (Expansion of Systems and Services) (Building a safety evaluation environment in Virtual Space)

1. Summary of the DIVP® (Driving Intelligence Validation Platform) Consortium

We have worked on creating a virtual safety verification platform, Driving Intelligence Validation Platform, DIVP®, through participating in the "Strategic Innovation Promotion Program (SIP) Phase Two - Automated Driving (Expansion of Systems and Services) (Building a safety evaluation environment in Virtual Space)". We aim to enable simulation models (that mimic driving environment objects, electromagnetic wave propagations, and sensors) of high real-virtual consistency that can be used on behalf of actual experiments in a real environment through the platform.

The DIVP® consortium is an industry-academia organization composed of 12 organizations such as sensor manufacturers, software companies, and universities (Fig.9). In addition, the Consortium is collaborating with the SAKURA project promoted by the Japan Automobile Manufacturers Association, Inc. (JAMA) and the Japan Automobile Research Institute (JARI) for contributing automated driving safety validation approach global standardization.

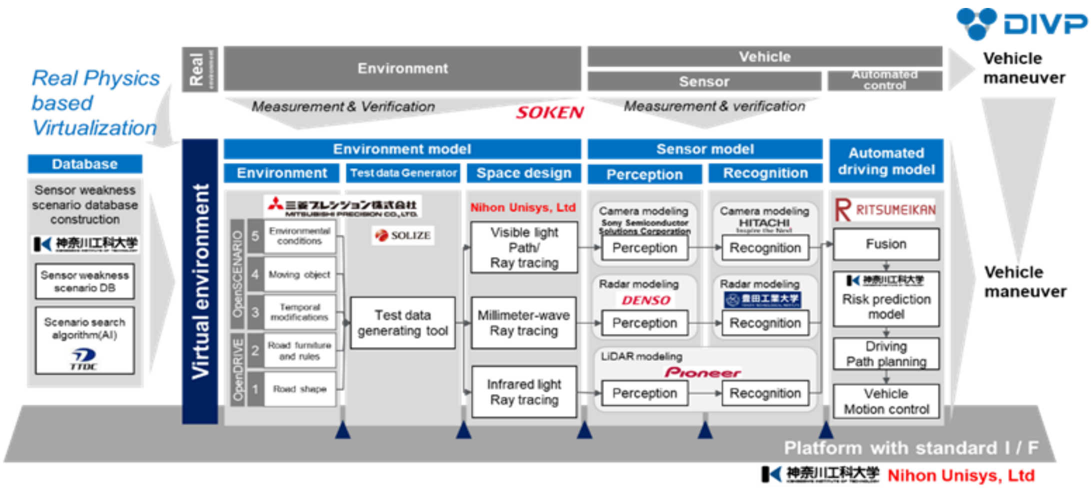

Fig.9 DIVP Project

2．DIVP® Theory

Unlike ordinary vehicle component models, sensors that recognize the environment conditions play a pivotal role in connecting driving environment models and automatic driving control. In general simulators, the main focus is on evaluating whether the system control works correctly, and many sensing models are based on so-called ground truth (normal) models, that is to say functional models. It is necessary to understand the strengths and weaknesses (limitations) of each peripheral monitoring sensor, and to improve the system design, sensors, and perceptual recognition algorithms in order to guarantee the safety of automated driving vehicle.However, it is difficult to reflect the weaknesses of sensors in simulation models because functional sensor models do not reflect the verification results of the spatial propagation of electromagnetic waves.

We of the DIVP® Consortium have been developing a spatial propagation model enabled by a ray tracing system based on the reflection characteristics (retroreflection, diffusion, specular reflection, etc.) and transmission characteristics of visible light for camera, millimeter wave for radar and near-infrared light for Lidar. Our model is furthermore capable of capturing the physical phenomena that change under the influence of the surrounding environment such as rain, fog, and ambient illumination. The unique feature of our model is that it is composed of a series of perception models predicated upon the electromagnetic wave principle of "driving environment objects – electromagnetic wave propagations - sensors" as perception models (Fig. 10). Thus, the model reflects views of spatial propagation characteristics recognized by the sensors. Specific examples are shown below.

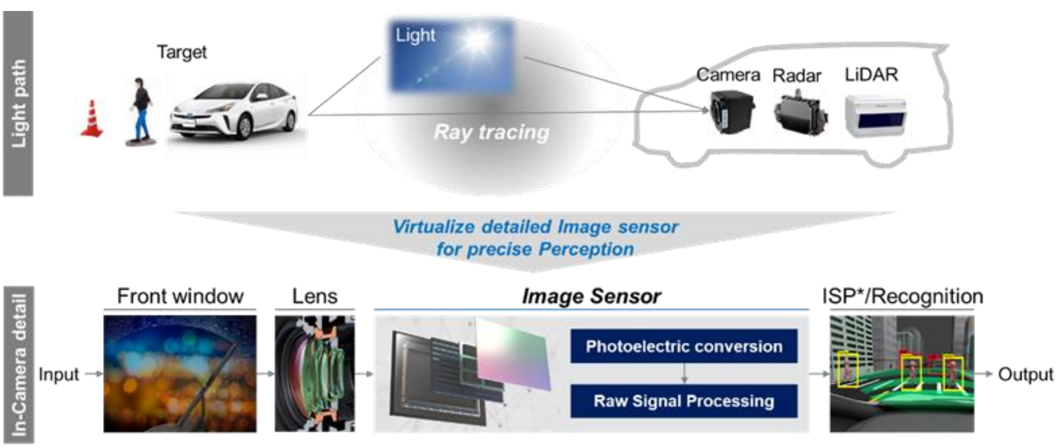

Fig.10 Sensor Modeling

Table 2 DIVP® Validation Platform Features

	Conditions		Evaluation Items
Camera	Normal	Vehicle outdoors in a fine weather	Brightness of each asset
	Malfunction	Diffusion by rain	Attached onto a windshield
		Night	Brightness of each asset
millimeter wave for radar	Normal	Vehicle	Reflection strength, Distance attenuation
	Sensor weakness	Wall surface multipath	Ghost reproduction Wall surface reflection strength
LiDAR	Normal	Without background light	Reflection point number, strength, recognition results
	Sensor weakness	Attenuation by rain	Reflection strength
		With background light	Wave-shape
		Pedestrian putting on a black-leather wear	Recognition limit distance

Shooting result by actual camera   SIM result (SKYLIGHT data: fine weather)

Fig.11 Actual camera output (left) and simulation output (Right)

3. Interfaces that We Need for DIVP®

The DIVP® Consortium now develops and improves interfaces for the DIVP® Platform to accept seamlessly users' simulation data of scenarios, environments and models that they use in the research on automated driving. Participants can operate their sets of simulation data on the DIVP® Platform until they know fully the fidelity of DIVP®-delivered mimics of actual sensor performances (Fig.12). The Consortium aims to specifically develop scenarios fit for OpenSCENARIO® and OpenDRIVE® as well as interfaces in the system environment and Open Simulation Interface (OSI) (ASAM standard) complying with FMI/FMU.

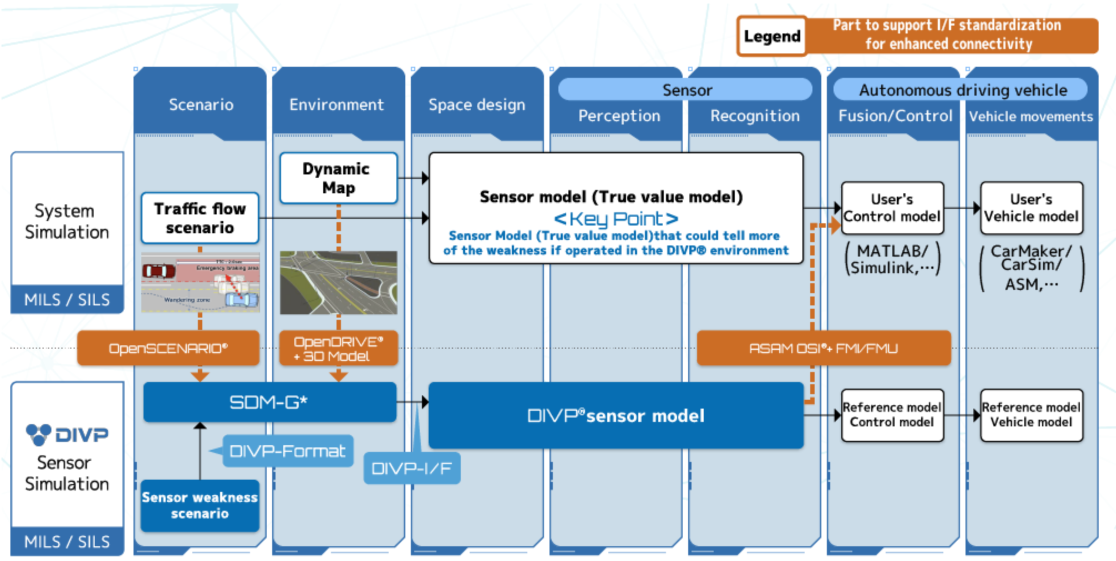

Fig. 12 Ensuring the simulation interfaces through OpenX and ASAM OSI

4. Use of DIVP® Halfway Deliverables

The DIVP® Platform ensures the real-virtual consistency in simulation deliverables through providing an opportunity of checking simulation outputs at the halfway point in the simulation process of perception and recognition in addition to the end point. Fig. 13 indicates an output interface (IF) summary for a millimeter wave radar simulation.

Participants can select from options of [1] space design output, [2] perception output, and [3] recognition output and use in units of sensor for cameras, millimeter wave radars, and LiDARs.

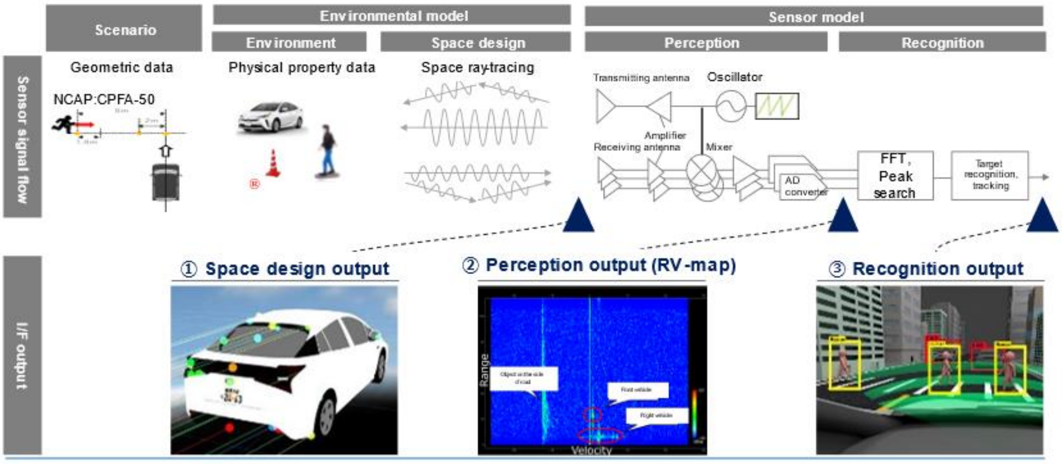

Fig. 13 Halfway-point output example of millimeter-wave radar simulation on the DIVP® Platform

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