# Application Guidelines for Participating in the Tokyo Waterfront City Area Field Operational Test (through simulation) for 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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# 1 Introduction

Automated driving vehicles are expected to be implemented in society in the future and currently reliability and safety validation mostly done by actual vehicle validation tests. A huge amount of resources (human resource, materials, cost, and time) is required in order to validate a safety in various traffic environments. Based on the situation above, in this Driving Intelligence Validation Platform (DIVP® )" project funded by 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).

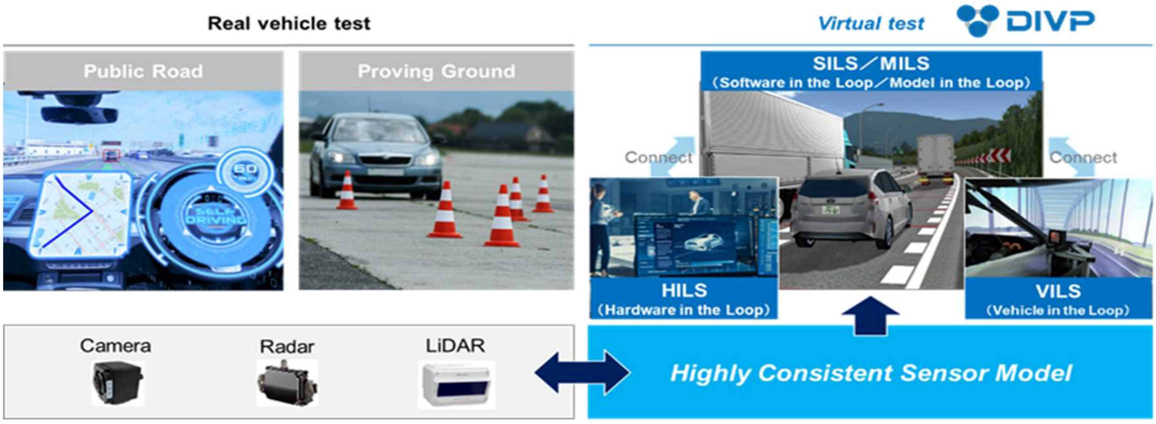



Fig. 1 Features of **DIVP®** : Highly consistency sensor modeling with real phenomena

The purpose of this Field Operational Test is to provide opportunities reviewing DIVP® simulation results and consistency vs real parts vehicle test results data. The DIVP® Platform has been developed with the capabilities of precisely duplicated of real physics through the "driving environment objects – electromagnetic wave propagations - sensors" models. Participants can review the usefulness of simulation performance & capabilities and give us their feedbacks for further improvements.

## 2 DIVP® Consortium

The DIVP® consortium is an industry-academia organization composed of 12 organizations such as sensor manufacturers, software companies, and universities (Fig.2).

In addition, DIVP® 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.

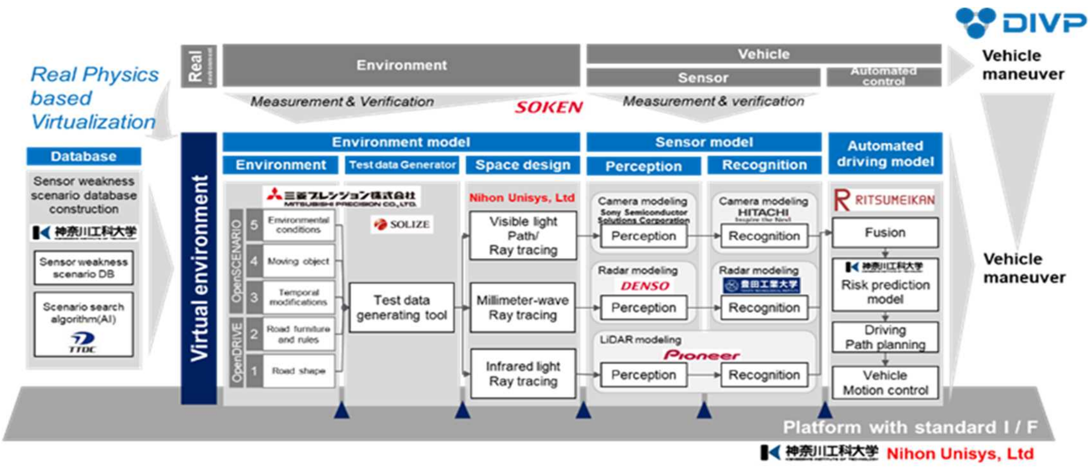



Fig. 2 DIVP® project design

Unlike ordinary vehicle component models, sensors that recognize the environment conditions play a pivotal role in connecting driving environment models and automated driving control models. In general simulators, the main focus is to validating whether the system control works correctly, and many sensing models are based on so-called ground truth (normal) models, that is generally defined as functional models.

It is necessary to understand the strengths and weaknesses (limitations) of each sensors, and to improve the system design, sensors, and perceptual recognition algorithms in order to assure the safety of automated driving vehicle.

However, it is difficult to duplicate the sensing weaknesses phenomenon in the simulation models because the functional sensor model does not contain 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 duplicate the real physics that has 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. 3). Thus, the model reflects views of spatial propagation characteristics recognized by the sensors. Specific examples are shown below.

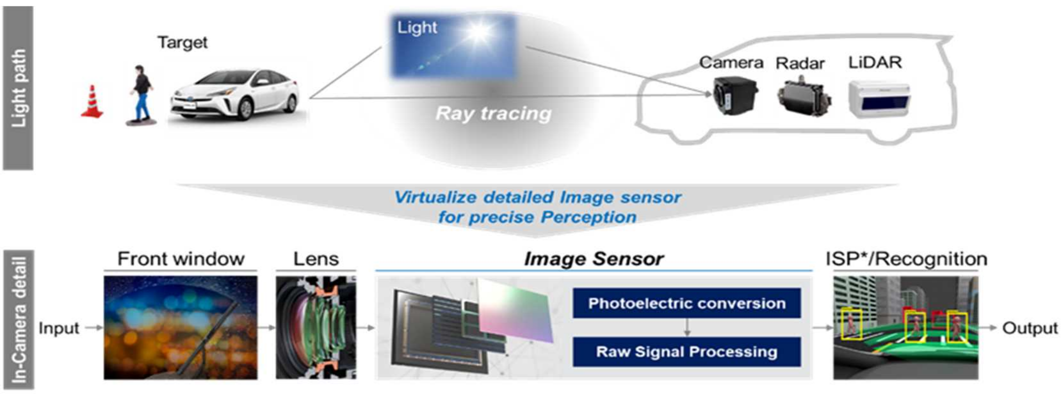



Fig. 3 Sensor modeling strategy

Table 1 DIVP® Validation Platform Features

| | Conditions | | Evaluation Items |
|---|---|---|---|
| Camera | Normal | Vehicle outdoors in a fine weather | Brightness of each asset |
| | Sensor Weakness | Diffusion by rain | Attached onto a windshield |
| | | Night | Brightness of each asset |
| 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 |
| Millimeter wave radar | Normal | Vehicle | Reflection strength,<br>Distance attenuation |
| | Sensor Weakness | Wall surface multipath | Ghost reproduction<br>Wall surface reflection strength |


Fig. 4 Actual camera output (left) and Simulated output (Right)

## 3 Operation Summary

### 3.1 Summary of the Test

Participants will access simulation results of the "driving environment objects – electromagnetic wave propagations - sensors" models run on a prototype version of the DIVP® Validation Platform (Fig. 5) and related data. Participants are expected to confirm how useful the Platform is for developing and evaluating automated driving vehicles. (The simulation results are output mainly in the formats of image and moving picture as exemplified in Fig.6.)

We have prepared packaged scenarios (as described herein at 3.4.2) for the Field Operational Test. The simulation scenarios are created from actual measurements in virtual environments of (1) NCAP definitions and (2) the Tokyo Waterfront area (Odaiba).

Participants will be able to check results of executing the packaged simulation scenarios, and will be aware of sensors' likely weaknesses (limitations) that can be exposed in the real world where actual environmental factors (such as driving environment, road, terrain, and weather) are mixed.

Thus, participants will be able to recognize that a furthermore efficient safety verification will be enabled through setting conditions in our highly reproducible virtual space.

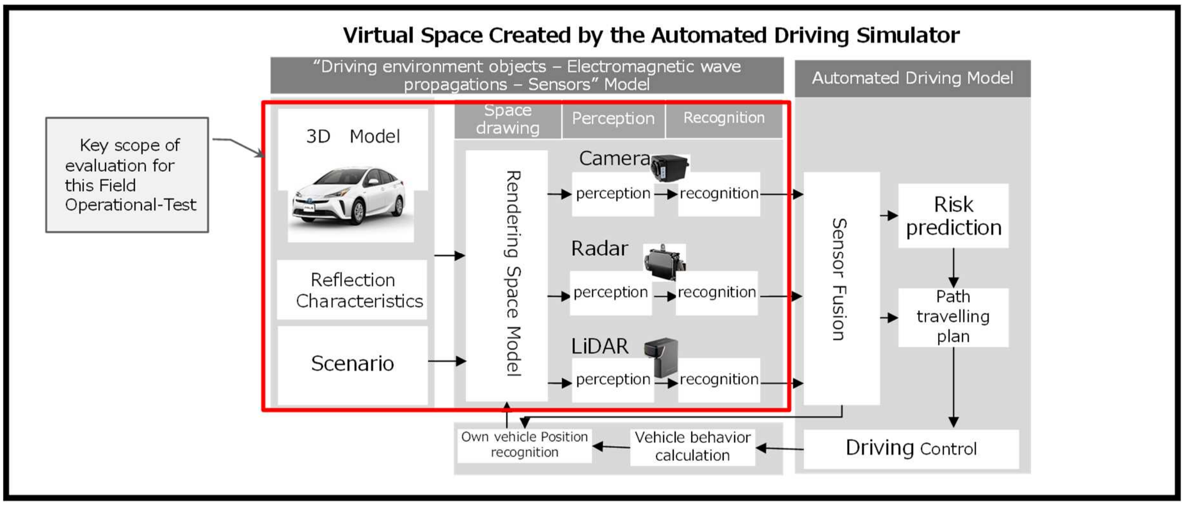
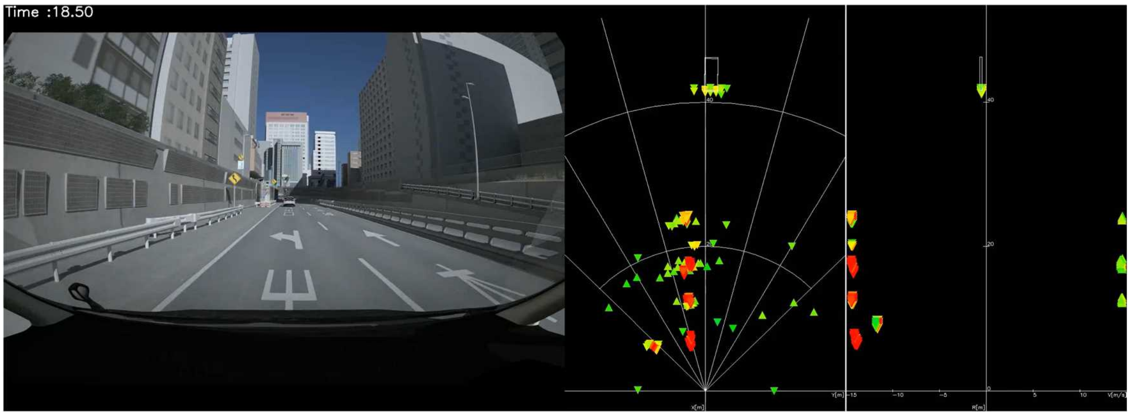



Fig.5 DIVP® Validation Platform (Prototype Version)

Key Scope of Evaluation for this Field Operational Test

(Camera output) (millimeter-wave radar output)




(LiDARoutput)

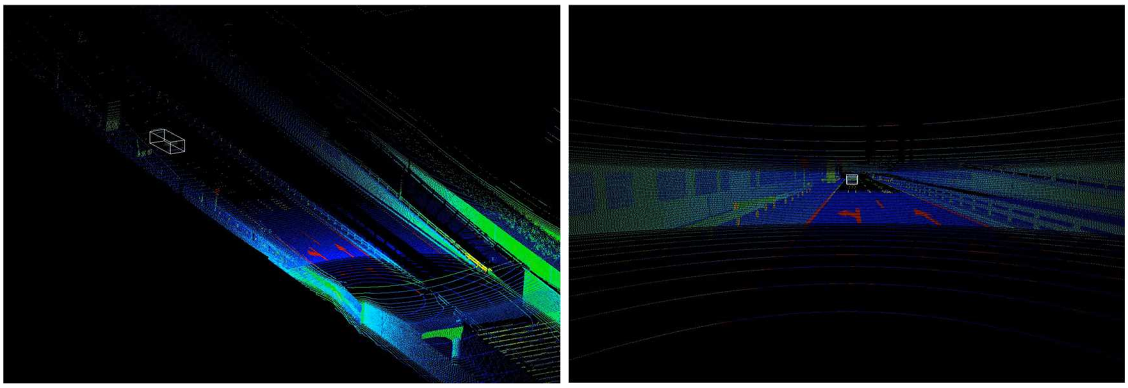


Fig.6 C1 Area Reproduced on the Simulator

(from Hamazakibashi Junction to Edobashi Junction)

## 3.2 Test Period

From November 2, 2021 to the end of January 2022
(See the summary of activities below)

## 3.3 Assumed Participants in the Field Operational Test

Automobile manufacturers, suppliers, vendors of related systems and tools, institutions such as universities, and research institutions involved in research and development of automated driving technologies as well as certification organizations, at home and abroad

## 3.4 Operation Contents

### 3.4.1. Establishment of a Portal Site Dedicated for the Field Operational Test

The organizer will prepare a dedicated server and establish a portal site where participants can access results of simulations executed on our DIVP® Validation Platform and related information.
Participating companies will have their own ID issued (to verify their identity). Multiple users of a participating company can use the portal site freely upon their ID authentication.

*Participants will be saved from operational burdens of executing simulation scenarios by themselves. The organizer will execute scenarios and prepare results supplemented with related data for their perusal.

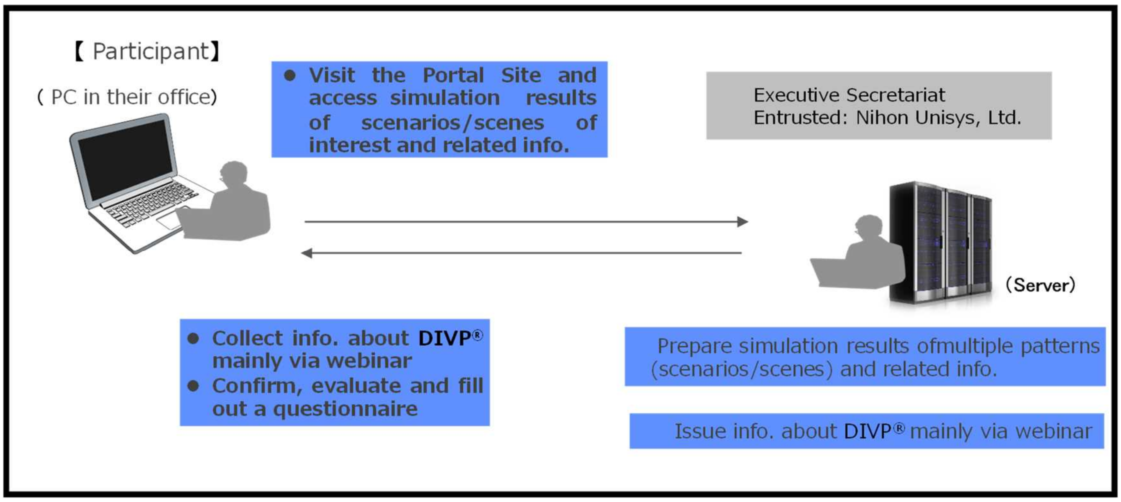



Fig.7 Conceptual Diagram for Simulation Experience

### 3.4.2. Simulation Results that Participants can Relive

1） Types of Simulation Patterns

Participants can confirm results of simulation scenarios executed on the DIVP® Validation Platform by operating sensor models (camera, millimeter wave, and LiDAR) under a variety of ambient conditions mainly about day & night and sunshine (Fig.11) in the environment models mainly of NCAP (Fig.8) definitions, the Odaiba Area (Fig. 9), and the Tokyo metro C1 highway (Fig. 10). Results data will be supplemented with related information.

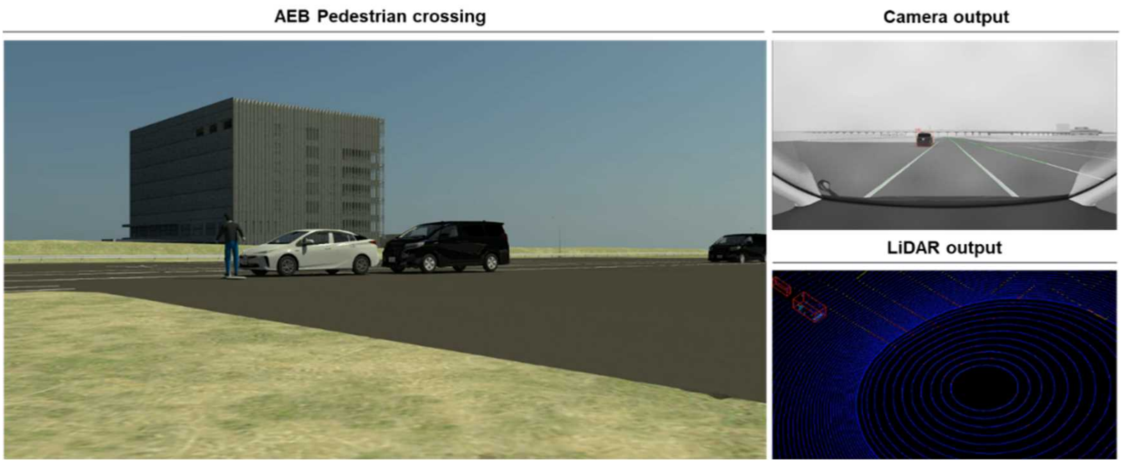



Fig. 8　Eur-NCAP Pedestrian crossing


Fig. 9　Odaiba Station area

Fig. 10　Tokyo Metro C1 Highway Tunnel

Fig.11 Changes in  Sunshine Conditions

２）Packaged Scenarios

We of the DIVP® Consortium have endeavored to enable system verifications that can be easily enhanced through mixing environmental verification factors in order to expose various weaknesses of sensors that may not be found in standard evaluation scenarios. Our aim is to enable efficient evaluations of automated driving systems. Thus, we have been preparing packaged scenarios in accordance with this intention.

We have prepared two packaged scenarios for this particular program (Table 2).Participants can view results of executing simulation scenarios, (1) an assessment scenario that reproduces patterns used in the NCAP environments and (2) a scenario in a reproduced environment of Odaiba, an actual site at the Tokyo Waterfront area. The scenarios are simulated by using sensor models, camera, millimeter wave radar, and LiDAR.

Table 2　Relivable Sensor Models and Packaged Scenarios（Planned）

| | |
|---|---|
| Verified Sensor Models | ■ Camera　1 model<br>■ Millimeter- wave radar　1 model<br>■ LiDAR　2 models |

| **Types** | Contents of Packaged Scenarios |
|---|---|
| Assessment scenario | ● Equivalent to JNCAP CPNC-50<br>（Pedestrian crossing behind a vehicle）<br>➢ Sim type : Closed Loop<br>➢ Vehicle speed : 25km/h<br>● ALKS: Proceeding Vehicle Cut-In<br>➢ Sim type : Closed Loop<br>➢ Vehicle speed : （self）40km/h、（preceding）20km/h |

| | |
|---|---|
| Scenario of actual environment | ● Maritime Sub-city Center area（Odaiba）<br>➢ Sim type : Open Loop<br>➢ Camera<br>✧ Recognition error in the shade of a tree<br>✧ Reproduced light-distribution properties of a traffic light<br>➢ Millimeter wave rader<br>✧ Faded/cluttered on a road surface<br>➢ LiDAR<br>✧ Pedestrian of a black-dyed leather wear coming out of nowhere<br>✧ Travelling on a road painted with a thermal barrier |

3）Output Formats for Simulation Results

Our flow of processing simulation results for each sensor includes two intermediary phases of perception and recognition before the final phase of recognition output in order to ensure the consistency of sensor recognition.
The output interfaces (IFs) of each sensor are illustrated in Fig. 12.

We will have prepared results of executing simulation results at the phases of perception output IF and recognition output IF for this Field Operational Test.
Participants will view the data in the formats of viewer image and moving picture (Participants can avail themselves of a Ros-Bug format on a restricted basis. Please contact the Executive Secretariat for our separately service.)

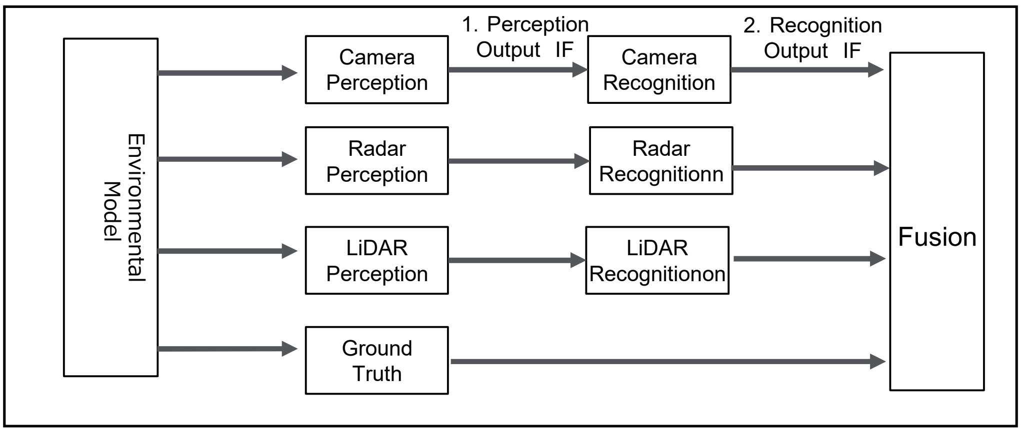



Fig.12 Output Interfaces

### 3.4.3. Webinar Briefing Sessions on DIVP® Details

We plan multiple briefing sessions via webinar during the duration to give an idea of consistency between actual phenomena and simulation execution results demonstrated as a key feature of our DIVP® Validation Platform (as indicated in Table 1), and other series of functions as well as how users avail themselves of the platform. We will announce separately schedules and contents of the sessions.

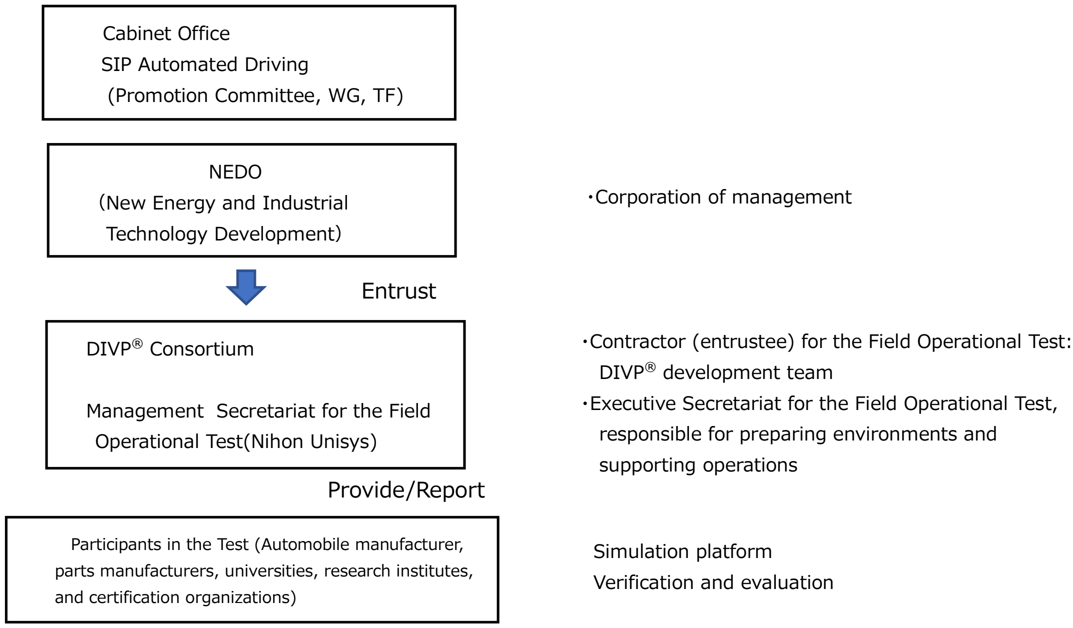
## 3.5 Requests to Participants

Participants will be exposed to results of execuing on the platform simulation scenarios in accordance with NCAP scenes and in the environments of Odaiba area and Tokyo metro C1 highway, as well as related data. They are kindly requested to give us their feedback reporting mainly on assumed effects and usability of the DIVP® Validation Platform if they use it for their business after confirming the data. We will provide opportunities where participants express their free opinions and out-of-the-box ideas about using the automated driving simulation system partly as a service.

We will reflect your feedback as precious inputs in promoting our future study and developments at the DIVP® Consortium

### 3.6 Operation and Management Organigram

Please find below our operation and management organigram.




## 4 Participation Requirements and Selection

### 4.1 Participant Requirements

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

2 )Participant that satisfies either of the requirements below:

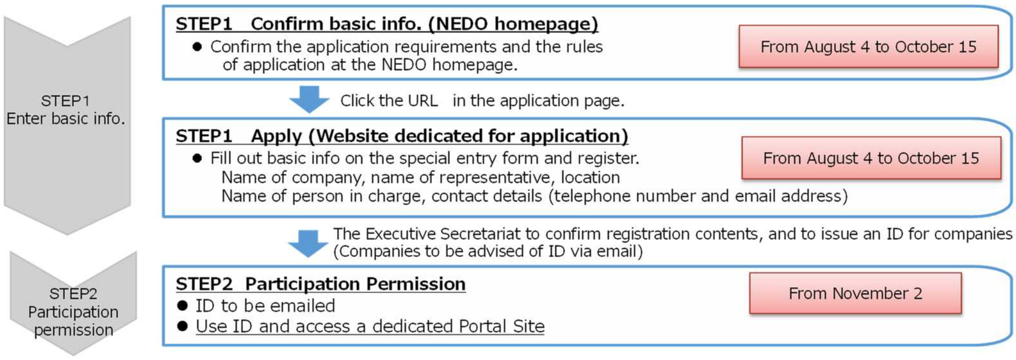
-participant that has obtained experience in development and capability evaluation based upon simulation from, or is considering the use of simulation through taking part in research and development about as well as evaluation of automated vehicles and related systems;

-participant that is interested in and has ideas about using simulation about automated driving and services based on simulation

3)Participant that agrees to the “Rules for Participation in the Tokyo Waterfront City Area Field Operational Test (through simulation)” (separately attached)

4.2 Application Procedure

1) Fill out basic information on an entry form (in Japanese or English at a portal site established for the dedicated use)
2)Screening by the DIVP® Consortium of NEDO
3)Receive a screening result (with a participant ID to access the portal site)
4)Begin to use the portal site




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 Field Operational Test is used for any other purposes, the person shall be informed of the use and requested for consent in advance.)

4.4 Notes about Application

1) An application may not be accepted if made in an incomplete entry form.
2) NEDO and the DIVP® Consortium will decide on participants through our screening and selection process. Inquiries about the process will not be accepted.

4.5 Application Duration

Wednesday, August 4, 2021: The application begins
Friday, October 15, 2021: The application deadline

4.6 Notification

Applicants will be notified of screening results in the middle or the latter half of October 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 (through simulation) for 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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