# The Second Phase of SIP - Automated Driving for Universal Services Final Results Report:

# Introduction

The five-year efforts of the second phase of the SIP-adus (2018-2022) are summarized in the Final Results Report. The structure and content of the chapters of this report are described below, and together with the Mid-Term Results Report (SIP 2nd Phase: Automated Driving for Universal Services—Mid-Term Results Report 2018–2020) published in 2021, we hope that this report will be of assistance to you in your future research and development efforts.

## Chapter 1 The Second Phase of SIP-Automated Driving for Universal Services (Overview)

Chapter 1 describes the policy positioning of SIP and promotion framework and the main achievements in the second phase of SIP-adus, and summarizes the efforts of each ministry and agency.

The Japanese government has set forth the goal of the realization of Society 5.0 (Fig.1) in the Fifth Science and Technology Basic Plan, and the Cross-ministerial Strategic Innovation Promotion Program (SIP) is positioned as a core program for the realization of Society 5.0.

Society 5.0 is defined as "a human-centered society that achieves both economic development and solutions to social issues through a system that achieves a high level of integration of cyberspace (virtual environment) and physical space (real space)." In this context, automated driving is considered an important theme for the realization of Society 5.0 because it is expected to contribute to economic development through the creation of new data industries such as those for road traffic environment data and the expansion of the sensor market, and to solving social issues such as ensuring safe and secure means of transportation. Following the first phase of SIP, the automated driving was adopted as one of the subjects.

In the SIP-adus, taking advantage of its characteristics as an industry-academia-government collaboration project, research and development has focused on issues that should be addressed in coordinated industry efforts, such as the construction of digital infrastructure, technological development to ensure safety, standardization, and fostering public acceptance. (Fig.2)

We believe that we can contribute to the early realization of an automated driving society by cooperating as an industry and competing in vehicle development.

Please refer to Chapter 1 "The Second Phase of SIP-Automated Driving for Universal Services" for the efforts of the National Police Agency, the Digital Agency, the Ministry of Internal Affairs and Communications, the Ministry of Economy, Trade and Industry, the Road Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, and the Automobile Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, which are the members of the Steering Committee of the SIP-adus program.

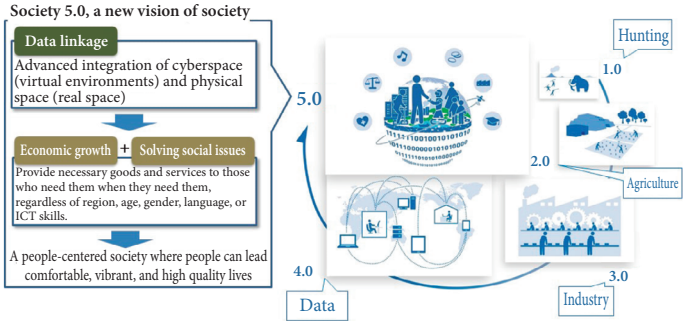



Fig.1: Society 5.0


Fig.2: Technologies and issues in the cooperative area

# Chapter 2 Establishment and Utilization of Traffic Environment Data

In order to realize advanced automated driving, it is necessary to build and utilize a framework for road traffic environment data, including high definition 3D map data for "localization" and route planning, traffic regulation information, accident information, traffic congestion information, and traffic signal information.

We call this database of road traffic environment data necessary for automated driving a "Dynamic Map" and have organized it into a concept stratified by four layers, as shown in Fig.3.

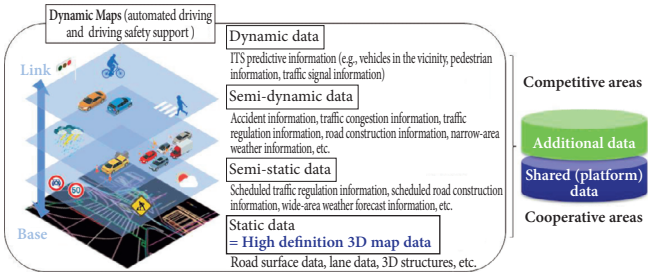
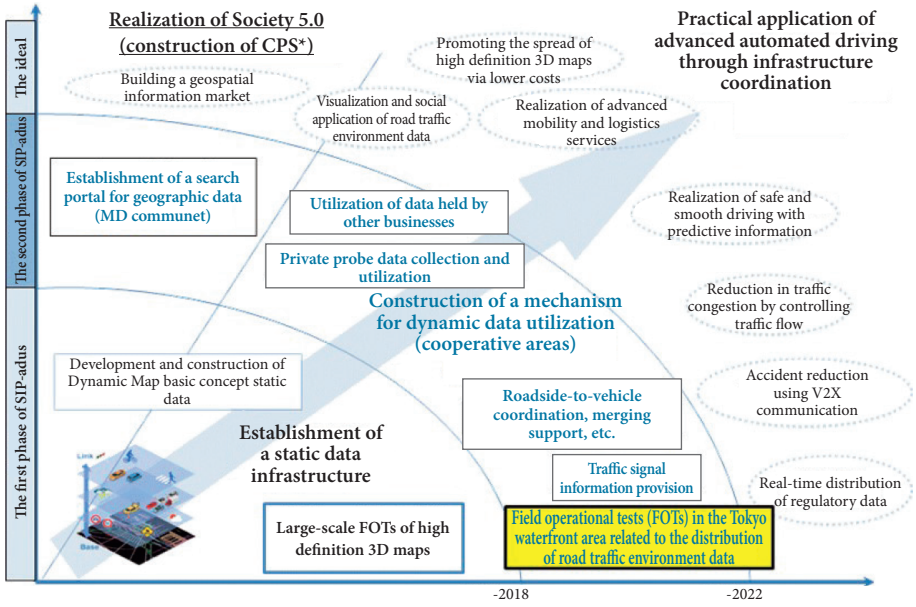



Fig.3: Dynamic Maps

In the first phase of SIP-adus, we worked on the construction and distribution of high definition 3D maps. Based on the results of this research, Dynamic Map Platform Co., Ltd. (DMP) was established in 2017 and began distributing approximately 30,000 km of high definition 3D maps of exclusive motorway nationwide in 2018. Subsequently, the world's first automated vehicle equipped with these maps was launched, and the maps are also being used by several automobile companies for their Advanced Driving Assistant System.

In the second phase of SIP-adus, we worked on the establishment of a mechanism for utilizing dynamic road traffic environment data associated with these high definition 3D maps. Based on the results of interviews with participants in the FOTs (Field Operational Tests) in the Tokyo waterfront area, it was found that traffic signal information, merging lane assistance information, lane-level traffic congestion tail information, emergency vehicle information, and rainfall information were given high priority, so it was decided to generate and distribute such information in conjunction with high definition 3D maps for verification purposes. (Fig.4)

The Tokyo waterfront area was selected to coincide with the




CPS*: cyber phisical system

Fig.4: Road Traffic Environment Data Roadmap

Tokyo 2020 Olympic and Paralympic Games, and SIP-adus prepared and distributed the equipment to receive this information in order to create the experiment environment and to invite a wide range of participants. As a result, a total of 29 organizations, including domestic and foreign automobile companies, suppliers, startup companies, and universities, participated in the experiment. They evaluated the effectiveness, accuracy, and format of the dynamic data and validated the safety of the automated vehicles developed by each organization.

V2I (Vehicle to Infrastructure) and V2N (Vehicle to Network) were selected as the communication methods, depending on the data to be distributed. The experiment showed that V2I is on track for practical application in traffic signal information distribution, and that V2N has big potential for road traffic environment data distribution. These results will be applied to the Ministry of Economy, Trade and Industry and Ministry of Land, Infrastructure and Transport project RoAD to the L4, and the V2I facilities for SPaT (Signal Phase and Timing) information distribution in Odaiba will be used for "Construction of smart mobility platform" for the next-phase SIP.

The details of The FOTs in the Tokyo waterfront area and the efforts made to build a road traffic environment data framework are summarized in Chapter 2 (1) "Technological Development Concerning the Generation of Traffic Environment Data". (Fig.5)

Based on the results of the FOTs in the Tokyo waterfront area, the automotive and telecommunications industries jointly discussed new communication methods for the future, and worked on the creation of a Roadmap of V2X Communication Methods for Cooperative Driving Automation. In addition, research was conducted to solve issues that will arise when V2N becomes widely used in the future, such as communications traffic.

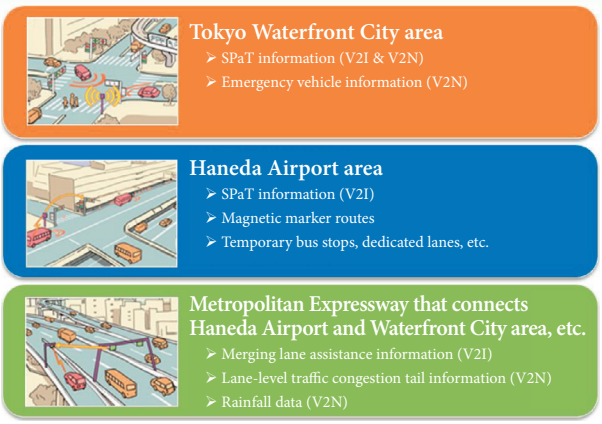



Fig.5: The FOTs in the Tokyo waterfront area

These studies on communication methods for cooperative automated driving are summarized in Chapter 2 (2) "Technological Development Concerning the Transmission of Traffic Environment Data".

# Chapter 3 Ensuring the Safety of Automated Driving

The biggest challenge in automated driving is ensuring safety. To mitigate anxiety and fears associated with a system being in charge of automated driving, and to clarify responsibility in the event of accidents, it is necessary to prove safety. The SIP-adus regards FOTs on public roads as an important means of verifying safety, and has thus promoted the FOTs in the Tokyo waterfront area.

On the other hand, safety verification requires evaluation under hazardous conditions that simulate accidents, and it is not possible to cover all of these issues with FOTs on public roads alone. For this reason, in the second phase of SIP-adus, an all-Japan team worked to construct a simulation environment that is highly consistent with the real environment and that enables the evaluation of sensor performance, which is important for automated vehicles. (Fig.6)

The simulation platform developed by the DIVP® (Driving Intelligence Validation Platform) Consortium has been commercialized, and V-Drive Technologies (a wholly owned subsidiary of BIPROGY) began sales to the public in September 2022.

DIVP is also working to improve the accuracy and usability as a safety assurance tool in collaboration with the AD-URBAN project by Kanazawa University and others, as well as with the safety assurance project SAKURA by the Ministry of Economy, Trade and Industry to develop safety assurance methods. These efforts of DIVP and AD-URBAN are described in Chapter 3, "Ensuring the Safety of Automated Driving."

Cyberattacks are another critical safety threat to automated

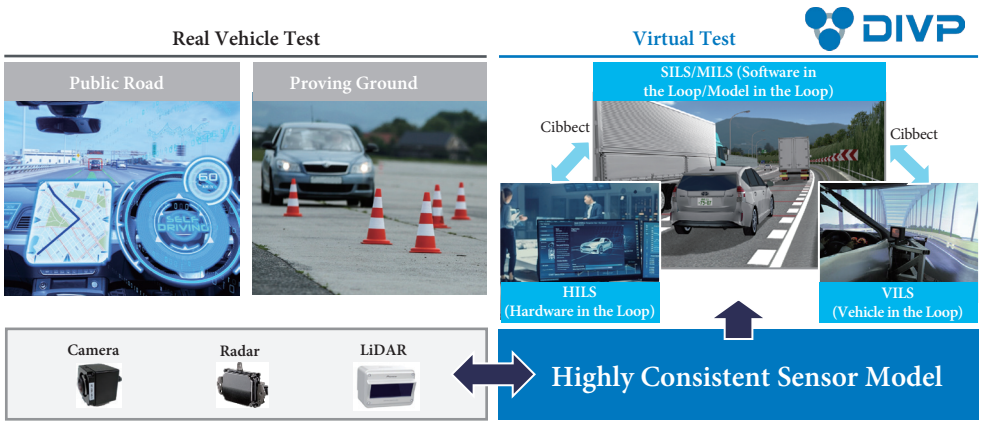



Fig.6: DIVP project

vehicles, which obtain the road traffic environment data via external communications while driving. Cyberattack methods are becoming more sophisticated year by year, and it is necessary to respond to their evolution.

In the second phase of SIP-adus, we worked on the research and development of measures against new cyberattack methods that are discovered after the vehicles are put on the market.

We worked on the "Formulation of Evaluation Guidelines for Intrusion Detection Systems (IDS)" in collaboration with JASPAR and on "Research on the Collection and Sharing of Threat Information for Connected Car" in collaboration with J-Auto-ISAC. The results were transferred to the respective organizations.

To ensure safety, it is necessary to supplement not only the hardware but also the soft aspects, including safety education for users and communication with traffic participants. These issues have been addressed through industry-academia collaboration, in conjunction with FOTs of mobility services in rural areas.

These safety-related efforts are also described in Chapter 3, "Ensuring the Safety of Automated Driving."

## Chapter 4 A Society with Automated Driving

SIP-adus is a program that aims to solve social issues by engaging in everything "from basic research to practical application and commercialization."

In depopulated areas in Japan, public transportation systems are being phased out due to declining profitability, and the elderly and other residents are facing an urgent need to secure means of transportation. As a consequence, it is important to achieve mobility services with automated driving as soon as possible.

For this reason, in the second phase of SIP-adus, we partnered with several local promotional organizations and municipalities to conduct long-term FOTs using a vehicle that has been modified from a golf cart using electromagnetic guide wires. As a result, services that meet local needs began at four Michi-no-Eki roadside stations (Kamikoani Village, Akita Prefecture; Higashiomi City, Shiga Prefecture; Iinan Town, Shimane Prefecture; and Miyama City, Fukuoka Prefecture), and are still being operated continuously. (Fig.7) Furthermore, based on the operational know-how from these areas, an implementation manual has been prepared and efforts are being made to expand the service to other areas.

These efforts are introduced in Chapter 4 (1), "Automated Driving Mobility Services in Regional Communities"

In order to promote the widespread use of automated driving, we believe it is necessary to promote a correct understanding of automated driving, to present concrete advantages and disadvantages, and to quantify various impacts (influences).

For this reason, in the second phase of SIP-adus, a large-scale questionnaire survey was conducted every year as a means of gaining a fixed-point observation of public acceptance. Efforts were made to develop methods for estimating the accident reduction effects and social and economic impacts of automated driving.

Fig.7: Mobility services in Kamikoani Village, Akita Prefecture

In addition, a long-term strategy was formulated to foster public acceptance, and information was actively disseminated to various stakeholders. These efforts are summarized in Chapter 4 (2) "Public Acceptance of Automated Driving."

## Chapter 5 Data Connection and Use to Achieve Society 5.0

As shown above, the SIP-adus has been working on the construction and utilization of geographic data, including Dynamic Maps. At the same time, Society 5.0 aims to realize a cyber-physical space that includes not only automated driving but also data coordination with other fields.

In the second phase of SIP-adus, "MD communet®" was launched in the spring of 2021 to promote the coordination and utilization of various geographic data held by the government and companies, and to establish a searchable portal site that gives a catalog showing the location and format of data and provides matching opportunities. (Fig.8) The number of companies that have agreed with the mission and become members has increased, and NTT DATA plans to continue to operate this project after the completion of the second phase of SIP-adus. This initiative and an app contest to promote data utilization are showcased in Chapter 5, "Data Connection and Use to Achieve Society 5.0".

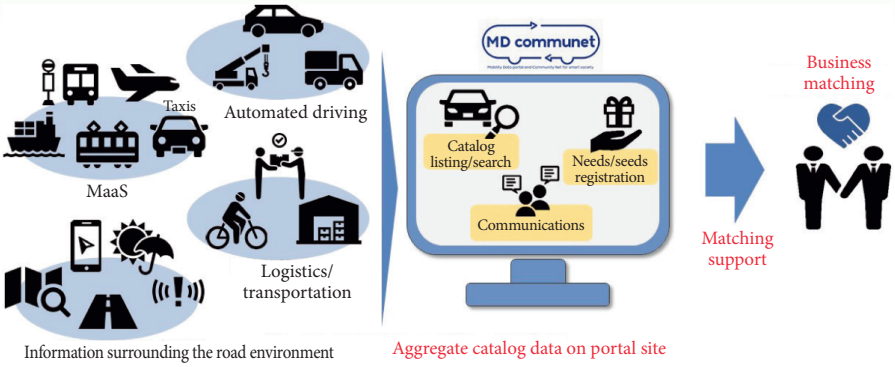



Fig.8: MD communet®

## Chapter 6 Promoting International Cooperation

The SIP-adus has focused on international collaboration since its inception in the first phase. Since the second phase, we have strengthened cooperation with standardization organizations in Japan, and we have also actively built a network focusing on Japanese-German and Japanese-EU cooperation by appointing an "International Cooperation Coordinator" as a contact point for international cooperation.

In addition, Dynamic Maps, human factors, safety assurance, connected vehicles, cybersecurity, socio-economic impact, and the promotion of service implementation have been designated as priority themes for international cooperation, and the theme leaders have taken the lead in promoting international cooperation activities, including the SIP-adus[1] Workshop. These activities are summarized in Chapter 6, "Promotion of International Cooperation."

## Chapter 7 Other Achievements and Activities

As explained so far, the SIP-adus has tackled a wide range of themes, and measures not included in this Final Results Report or themes included only in the Mid-Term Report are introduced in Chapter 7, "Other Achievements and Activities" due to space limitations. As described Chapter 4 "Public Acceptance of Automated Driving", we conducted a wide range of activities for PR, creating a website and another as SIIP-café (a web community for thinking about an automated driving society). How the contents of these websites will be remained after the second phase of SIP-adus conclusion is also mentioned in Chapter 7 "Other Achievements and Activities".

## Chapter 8 Conclusion and Outcomes through SIP-adus to be Inherited

When we include the first phase, the SIP-adus has been in operation for nine years, and in this time various collaborations in the area of automated driving have seen progress. The following is a review of the management innovations that have been developed through trial and error during this period. On the other hand, there is still a long way to go toward the realization of automated driving, and research and development will continue in the future. We would like to share with you messages from representatives of the RoAD to the L4 project by the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure, Transport and Tourism, which is ongoing with the goal of Level 4 automated driving, the next step in automated driving, while continuing to build upon the achievements of the SIP-adus program, and from the next SIP Secretariat, which will start in FY2023. A summary by the program director is also given in Chapter 8, "Conclusion and Outcomes through SIP-adus to be Inherited".

1 SIP-adus is an acronym for SIP Automated Driving for Universal Services