（provisional translation）

Cross-ministerial Strategic Innovation Promotion Program (SIP)

Automated Driving for Universal Services

R&D Plan

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Cabinet Office

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R&D Plan Overview

1. Vision and development goals

(Vision) There are high expectations for social changes stemming from automated driving. The “Public-Private ITS Initiative/Roadmap 2019” (June 2019) states that its “aim is to build the ‘society with the safest, smoothest roadway traffic in the world’ by 2030 by developing and deploying an automated driving system and associated data infrastructure.”

At the Council on Investment for the Future (March 2018), Prime Minister Shinzo Abe stated that “Automated driving will be implemented at the Olympic and Paralympic Games Tokyo 2020. Zones of the Tokyo waterfront area will be established as safer spaces for automated driving with traffic signal data transmitted to vehicles, among other strengthened initiatives aimed at various types of business development.” Working toward the realization of these initiatives, and their valuable leading role in achieving the Society 5.0 detailed in the 5th Science and Technology Basic Plan (January 2016), are considered to be significant both socially and industrially, and to represent Japanese contributions to the world at large.

(Development goals) To achieve a society in which all people can attain a high quality of life through the practical implementation of automated driving and its deployment, thereby contributing to various social problems such as by achieving fewer traffic accidents, less traffic congestion, greater mobility for vulnerable road users, and the improvement of driver shortages and lowering of costs in the logistical and mobility services.

These goals will be achieved as per the timetable in the “Public-Private ITS Initiative/Roadmap 2019”, but early accomplishment of the goals will also be considered based on international trends, technological developments, and other factors.

・Mobility services: Achieve high driving automation (SAE Level 4) for mobility services in limited regions (Operational Design Domain) by 2020.

・Logistical services: Achieve high driving automation in trucks (SAE Level 4) on highways around 2025 or later.

・Privately owned vehicles: Achieve high driving automation (SAE Level 4) on highways by 2025.

・Privately owned vehicles: Partial driving automation on general public roads (SAE Level 2 or higher).

The cooperative area technologies essential to achieving these goals will be established by 2023. The effectiveness of the technology will be validated through FOTs (Field Operational Tests) involving a variety of business operators, local government bodies, and others, and practical implementation in society will be achieved to a certain level through the establishment of multiple practical example cases for commercialization in which the technology is actually implemented.

2. Research and development

In order to practically implement and deploy automated driving technology, both vehicle development and the development of the driving environment are required. The SIP-adus (Cross-ministerial Strategic Innovation Promotion Program [SIP] Automated Driving for Universal Services) project is an industry-academic-government collaborative project to promote development, focusing on cooperative areas such as the development of driving environments. Although the development of automated vehicles is an area of competition and not cooperative, there are issues such as safety that should be tackled jointly across the industry. Therefore, this project will promote automated vehicle development by specifying cooperative-area technologies within that development process. In order to promote the propagation of the technology, it is also important to foster public acceptance of automated driving. The project will work to clarify the value and issues of automated driving and to have Japanese people develop a correct understanding of it, in addition to conducting research to improve the services. International standardization will be pursued through international cooperation with the aim of seeing the R&D output of this project put to use in the global market.

The following four areas will be prioritized: I) The development and validation (FOTs) of automated driving systems; II) The development of core technologies for the practical implementation of automated driving; III) The fostering of the public acceptance of automated driving; and IV) The enhancement of international cooperation.

(I) Development and validation (FOTs) of automated driving systems

(1) FOTs in Tokyo waterfront area: 1. Preparation and operation of the transportation infrastructure for the FOTs, 2. Preparation of ITS wireless roadside devices for providing traffic signal data for the FOTs, 3. Study of plans for the FOTs in Tokyo waterfront area and evaluation of data.

(2) FOTs for the social implementation of transportation and logistics services in local regions.

(3) FOTs of data interrelation, focusing on road traffic environmental data related to automated driving

(II) Development of core technologies for the practical implementation of automated driving

(1) Road traffic environmental data utilization technology : 1. Research and development related to the update of the high-precision 3D map based on vehicle probe data and other data, 2. Research and development of the use of V2X data for safety assurance and other purposes under mixed-traffic environment, 3. Research and development for the sophistication of traffic signal data delivery and other technologies for the realization of automated driving, 4. Research and development on the provision of traffic signal data by methods other than roadside infrastructure to vehicle communication such as ITS wireless roadside devices, 5. Research and development on the collection, integration, and delivery of data of narrow-area and mid-sized-area information, 6. Research and development for collecting and utilizeing vehicle probe data, 7. Research and

development on recognition technology and other technologies necessary for automated driving technologies (levels 3 and 4), 8. Research and development for the location-based services using the Quasi-Zenith Satellite System "Michibiki".

(2) Safety evaluation technology: 1. Building an environment for virtual safety evaluations

(3) Other core technologies: 1. Research on HMI and others in accordancewith the sophistication of automated driving, 2. Investigation and research for countermeasures against new cyber-attack methods

(III) Fostering of public acceptance of automated driving

(1) Delivery of information to the public and fostering of public acceptance: 1. Formulation and evaluation of strategy for fostering public acceptance, 2. Planning and promoting events during automated driving FOTs and other opportunities for citizens, local government staff, and related businesses, etc.)

(2) Investigation and research for the resolution of social issues by automated driving technologies: 1. Evaluation of impacts of automated driving on the reduction of traffic accidents, 2. Sophisticated driver-assistance systems for those with vision disturbance or other handicaps

(IV) Enhancement of international cooperation

1. Delivery of information to the world through SIP-adus Workshop (international workshop) and other opportunities
2. Promotion of joint research in automated driving with overseas research organizations

3. Implementation structure

Program Director Seigo Kuzumaki (hereinafter “PD”) manages the Steering Committee, drafting research and development plans and strategies on technologies as well as conducting industry-academic-government collaborative discussions on deployment milestone. Application procedures and procurement specification documents are created by the ministries/agencies and the New Energy and Industrial Technology Development Organization (NEDO) as the management agency.

4. Intellectual properties and their evaluations

Intellectual properties and their evaluations are handled based on Guidelines for the Cross-ministerial Strategic Innovation Promotion Program (authorized by the Governing Board).

5. Deployment Milestones

In terms of Deployment Milestones, this program sets the Olympic and Paralympic Games Tokyo 2020 as a milestone in its aim to overcome three barriers to implementation and achieve success through industry-academic-government collaboration: developing the technology, the regulatory framework, and the public acceptance required. This work will combine with infrastructural

technology development and FOTs in the Tokyo waterfront area, regional areas, and elsewhere. These FOTs will promote investment through the participation of automobile companies, businesses, local government bodies, and other parties to help achieve implementation and commercialization of the technology. Moreover, the active use for a variety of purposes of maps and geographical data created to support automated and advanced driving technologies will be promoted to contribute to the achievement of Society 5.0.

1. Vision and development goals, etc.

(1) Background and domestic/international context

Interest in automated driving is on the rise every day. Car manufacturers, component manufacturers, and others are actively investing in research and development in this area, while on the national level there is also a proactive effort to attract participants in research and development projects and FOTs. There is also steady development of the regulatory framework and environment needed for implementation of the technology, centered primarily on Japan, the United States, and Europe.

In the background are likely other factors including the reduction of traffic accidents, less traffic congestion, greater mobility for the elderly and vulnerable road users, and other such solutions addressing problems in society, as well as the high expectation that automated driving will bring about social changes, including new logistical and mobility services and businesses.

In the United States, the company Waymo is conducting field operational tests of automated driving without drivers aimed at providing a new service. GM has announced the commercialization of a Driving Automation Level 4 product. In response, the National Highway Traffic Safety Administration (NHTSA) has revised its guidelines for automated driving and adopted a stance of promoting the development of automated driving technology. On the other hand, fears regarding the safety of the technology have been revived by fatal accidents occurring in early 2018 that involved Uber and Tesla vehicles in self-driving mode, once again launching debate on the issue.

In Europe, automated driving research is being pursued in national government programs, including the EU-funded research project Horizon 2020 and the German PEGASUS project. Germany has also taken the lead in revising its road traffic laws and is working to develop the environment needed for the implementation of automated driving technology.

In Japan, research and development was conducted in cooperative research and development areas pertaining to automated driving, primarily in the first phase of SIP beginning in 2014. Large-scale FOTs began in 2017. Bills of revising the Road Traffic Act and Road Vehicle Act passed in May 2019. Practical implementation on highways is expected to begin by 2020 as per the government’s strategy (“Growth Strategy Council - Investing for the Future” and “Public-Private ITS Initiative/ Roadmap”).

Based on this, the importance of automated driving development is also recognized in the second phase of SIP, and new projects have been set in motion aimed at achieving the next accomplishment along the path.

Japan is one of the first countries in the world to suffer shortages of transportation methods in under populated areas with increasingly older populations and a lack of drivers in the logistics industry, among other social problems. As a result, there is a strong desire in Japan for automated driving technology to be extended to general public roads, and for Japan to achieve the world's first commercialization of automated driving in the logistical and mobility services, thereby making Japan a model “super-aging society” in which all citizens can use transportation safely and with

peace of mind.

When this project was launched, its topic was changed from the “SIP Automated Driving System” program to the “SIP Automated Driving (Automated Driving for Universal Services)”. This was due to at least three factors: 1) The second phase of SIP is not a continuation or extension of the first phase of SIP; 2) Public-Private ITS Initiative/Roadmap 2017 used the increasingly common name “automated driving”; and 3) The transition from a phase focused on developing the technology behind automated driving systems to a phase in which services are expanded towards the end of implementing automated driving on a practical basis. Additionally, it was decided to continue using the English abbreviation “SIP-adus (Automated Driving for Universal Services).”

(2) Significance and strategic importance

This project aims to achieve the practical implementation of automated driving. In addition to the social significance of this technology—which could lower the number of traffic accidents, reduce traffic congestion, bring mobility to underpopulated regions, and alleviate driver shortages—it also has large economic significance as well.

At present, the automobile industry is being carried on waves of technological innovation including connected vehicles technology, automated driving technology, sharing technology, and electric vehicles technology. It is said that the world is in a once-in-a-century period of massive change. Triumphing over competitors in the development of this technology can be expected not only to increase the competitiveness of contemporary Japan’s automobile industry—one of Japan’s core, broad-based industries—but also to have ripple effects in related industries such as digital infrastructure, sensors, and communications that are required for automated driving. It can also be expected to create new industries and services for the era of Society 5.0, representing great potential to contribute to Japan’s future economic development.

On this basis, the “Public-Private ITS Initiative/Roadmap 2019” (June 2019) states that its “aim is to build the ‘society with the safest, smoothest roadway traffic in the world’ by 2030 by developing and deploying an automated driving system and associated traffic environmental data infrastructure.”

At the Council on Investment for the Future (March 2018), Prime Minister Shinzo Abe stated that “Automated driving will be implemented at the Olympic and Paralympic Games Tokyo 2020. Zones of the Tokyo waterfront area will be established as safer spaces for automated driving with traffic signal data transmitted to vehicles, among other strengthened initiatives aimed at various types of business development.”

Also, Integrated Innovation Strategy 2019 (June 2019) includes the implementation of a data interrelation infrastructure across different fields, the implementation of a data interrelation infrastructure in each field (automated driving), and architecture development (geographical data (automated driving)), for the preparation of a data interrelation infrastructure toward Society 5.0.

Working toward the realization of these initiatives, and their valuable leading role in achieving

the Society 5.0 detailed in the 5th Science and Technology Basic Plan (January 2016), are considered to be significant both socially and industrially, and to represent Japanese contributions to the world at large.

(3) Objective/Aim

(a) Overall objective

To achieve a society in which all people can live and attain a high quality of life through the practical implementation of automated driving and its deployment, thereby contributing to various social problems such as by achieving fewer traffic accidents, less traffic congestion, greater mobility for vulnerable road users, and the improvement of driver shortages and lowering of costs in the logistical and mobility services.

These goals will be achieved as per the timetable in the “Public-Private ITS Initiative/Roadmap 2019”, but early accomplishment of the goals will also be considered based on international trends, technological developments, and other factors.

・Mobility services: Achieve high driving automation (SAE Level 4) for mobility services in limited regions (Operational Design Domain) by 2020.

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・Privately owned vehicles: Achieve high driving automation (SAE Level 4) on highways by 2025.

・Privately owned vehicles: Partial driving automation on general public roads (SAE Level 2 or higher).

The technologies of the cooperative-area type necessary for achieving these goals will be established by 2023. The effectiveness of the technology will be confirmed through FOTs involving a variety of businesses, local government bodies, and others in the Tokyo waterfront area and underpopulated regions, and practical implementation in society will be achieved to a certain level through the establishment of multiple practical example cases for commercialization in which the technology is actually implemented.

Moreover, in the interest of international collaboration, this research and development plan uses SAE International’s J3016 (September 2016) and the Japanese translation thereof, JASO TIP18004l (February 2018), as its definitions for driving automation levels.

Current pursuit to automated driving development features two different approaches, as shown in Figure 1-1: (A) Research and development of automated driving under restricted time and spatial conditions, and (B) Research and development of application of the technology under a more diverse range of environments.

Attention tends to focus on approach (A) based on terminology like the “automated driving level” and expectations of “driverless driving.” However, approach (B) assumes there is a driver operating the vehicle and automated driving technology is used to achieve advanced automated driving

support. This approach serves to further enhance vehicle safety, contribute to reduced traffic congestion, and can help improve the competitiveness of the automobile industry by giving consumers more added value. Approach (A) is an innovative solution for addressing depopulation, driver shortages, and giving mobility to vulnerable road users, and there are great expectations that new businesses will grow out of this. Therefore, in order to utilize the technology of automated driving to contribute to the rapid achievement of these goals, both approaches are needed.

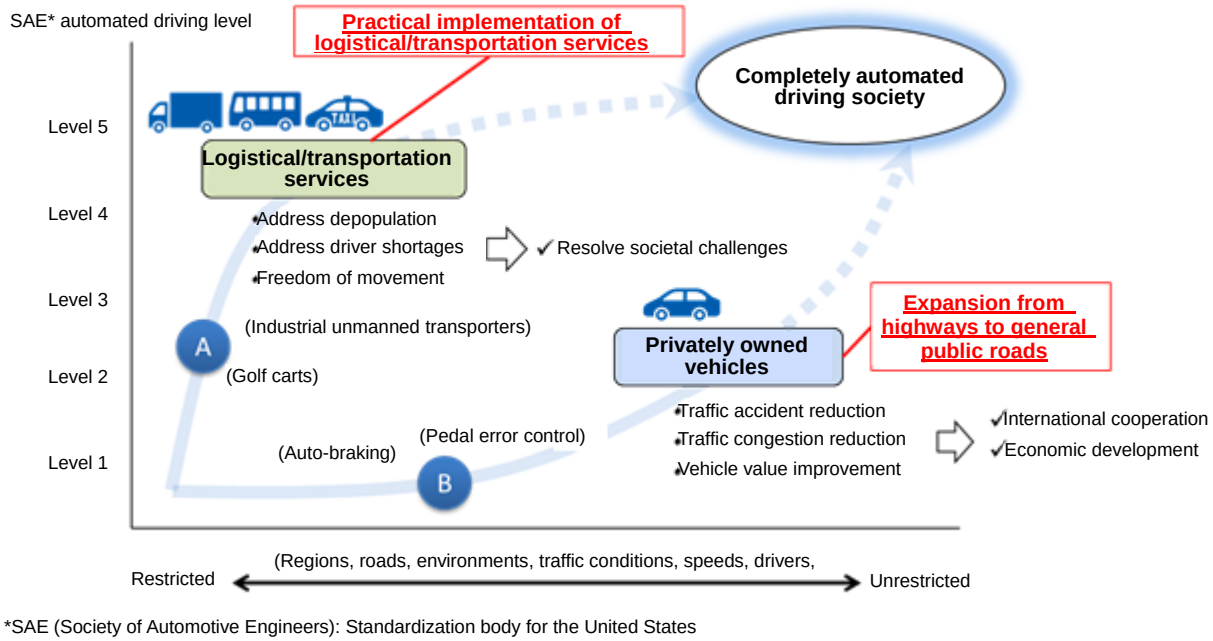


Figure 1-1. Overall vision of automated driving

(b) Achievement of Society 5.0

"Automated driving" means for a computer system to handle the driving that was previously conducted by human drivers.

To achieve this, it is necessary to collect a variety of roadway traffic environmental data and build a cyber-physical space for the system to use: these mean nothing less than the achievement of Society 5.0 itself. Vehicle probe data gathered in the course of the development of automated driving can be used for a variety of purposes, including updating maps and predicting traffic congestion. This roadway traffic environmental data can also be used to evaluate safety in a virtual environment via simulation. Furthermore, the map and geographical data obtained here can also be used in a variety of fields including infrastructure maintenance management, disaster preparedness and prevention, and "IT agriculture". This project involves collaboration with these fields while aiming to build a service platform for geographical data built on map data produced by automated driving, thereby contributing to the achievement of Society 5.0.

1) Begin use of vehicle probe data on automated driving and support systems (map updates, data provision, etc.).
2) Build a framework for the use and application of highly accurate map data, accident data, and

other traffic data.

3）Begin operating a service platform for the distribution of map data and dynamic geographic data.

4）Development of an architecture that is effective for data interrelation and other purposes through cross-field FOTs that use geographical data

(c) Social objectives

The transportation of people and things is an important element of life in society, and automated driving would likely have an impact on town planning and urban development itself. Combined with air, rail, and other forms of transportation, it is hoped that this project will contribute to local communities by thinking about how to use automated driving in a way that meets the needs of each region and specific use. There is also a need to consider the potential of progress that incorporates car-sharing and other new forms of vehicle ownership.

After creating an overall vision as above, the aim is to achieve a society in which all people can attain a high quality of life through the practical implementation of automated driving and its propagation suited to people's needs, thereby contributing to various social problems such as by achieving fewer traffic accidents, less traffic congestion, greater mobility for vulnerable road users, and the improvement of driver shortages and lowering of costs in the logistical and mobility services.

On the other hand, it is also true that there is a large gap between the expectations for automated driving held by the elderly and vulnerable road users, and the actual maturity of the automated driving technology itself. This project constitutes research on the level of driving ability necessary to operate a vehicle equipped with automated driving technology by verifying the effectiveness of advanced driving assistance systems for the reportedly large population of individuals with minor visual impairments and similar issues.

1）Start projects by around 2020 for underpopulated areas that utilize automated driving technology to promote mobility.

2）Reduce traffic accident fatalities through automated driving, and establish methods of predicting CO2 reductions achieved.

3）Clarify the benefits of driving assistance provided by advanced driving assistance systems to those with minor visual impairments and similar issues, and propose an appropriate systematic framework.

(d) Industrial objectives

To enhance and maintain the competitiveness of the automobile industry through the early practical implementation of automated driving, as well as collect and distribute new digital infrastructure industries using map/geographical data and vehicle probe data collected and distributed for automated driving, strengthen the competitiveness of the sensor industry, and cultivate the cyber security and simulation industries.

1） Start new logistics and mobility services using automated driving technology

2） Begin operating a service platform for the distribution of map data and dynamic geographic data.

3) Cultivate personnel to work with automobile industry-related software by building a virtual evaluation method.

4) Cultivate evaluation organizations and “white-hat hackers” that have advanced cyber security skills.

(e) Technical objectives

A wide range of technical issues must be overcome in the practical implementation of automated driving. This project, which undertakes development in a cooperative area, places a priority on research and development of the core technologies needed to ensure safety and to build environments in which automated-driving vehicles can operate. In the process of studying the establishment of driving environments for such vehicles, the format and transmission requirements of roadway traffic environmental data needed for automated driving are to be determined and the aim is to standardize them as well.

In safety evaluations of automated vehicles, it is difficult to assess the variety of phenomena that can occur on public roads using the actual vehicles, and therefore such evaluations require a vast number of man-hours. To alleviate this problem, initiatives are underway to build simulations for virtual evaluation and validation that simulate various different objects (vehicles, motorcycles, bicycles, pedestrians), weather conditions (rain, snow, backlighting, etc.), and transportation conditions (highways, general public roads, etc.).

As automated driving becomes more advanced, the quantity of data transmitted to and from the car will increase, creating a need to upgrade cyber security and transmission media to keep pace. There will also be technological development in order to continually improve cyber security techniques, the collection and usage of vehicle probe data, and the use of new communications technology (including V2X technology and similar). Research and development will be performed regarding the proper state of HMI (human-machine interfaces) with pedestrians and other traffic as participants, as automated driving improves and an increasing number of cars are equipped with automated driving. Results are reflected in the structure of vehicles.

1） Begin providing traffic signal data for the purpose of automated driving and advanced driving support.

2） Begin providing data for merger assistance on highways and other infrastructure data.

3） Begin providing roadway traffic environmental data that uses vehicle probe data.

4） Build a simulation environment for virtual evaluation and demonstration using MBD (Model-Based Design).

5） Research and develop cyber security technology for software updates, etc. to establish guidelines.

6）Establish HMI guidelines for the deployment of automated driving.

(f) Objectives pertaining to regulatory systems

With the formulation of “Charter for Improvement of Legal System and Environment for Automated Driving Systems” (April 2018; IT Strategic Headquarters), regulatory systems are being studied at the responsible agencies and ministries. This project serves clarify the key issues and accelerate discussion on regulations and regulatory systems in need of reform by planning out FOTs in the Tokyo waterfront area and FOTs regarding improved mobility and logistics/mobility services in underpopulated areas and similar, and then implementing business cases involving businesses, local government bodies, and other relevant parties. These initiatives will seek to avoid redundancy with the work of regulatory reform conducted at the responsible agencies and ministries, and aim to create a discussion place among government agencies and ministries where they can study in integrated manner. Further, these FOTs aims to serve as open international research and development sites and hubs for automated-driving research and development in Japan.

In the first phase of SIP, work to establish international standards was conducted in close collaboration with the Japan Automobile Manufacturers Association (JAMA), the Society of Automotive Engineers of Japan, and other organizations. Future work will involve deeper collaboration with organizations such as the Japan Auto Parts Industries Association (JAPIA) and the Japan Electronics and Information Technology Industries Association (JEITA) to improve standardization strategies in terms of both the de facto and the de jure standards.

At present, offers have been received by SIP-adus regarding participation in German-Japanese joint research and in EU-Japanese joint research projects. The second phase of SIP will provide support for joint research on automated driving with Japanese universities/research organizations and European/U.S. research organizations by, for example, establishing places for discussion oriented toward exploring joint research themes and adding conditions for public call for proposal. These initiatives will serve to build a long-term, continuous framework for international collaboration with the aim of providing leadership for standardization work.

1）Achievement of regulatory reforms consistent with the “The Policy (Outline) on Institutional Development by the Government toward the Realization of Highly Automated Driving Systems”.
2）At least three proposals for ISO standards.
3）At least 5 joint research projects with foreign research organizations on automated driving.

(g) Strategies in light of global benchmarks

Although there has been spectacular progress in automated driving technology, it is still expected to take quite some time before “Level 5” of driving automation is achieved, at which the technology could handle driving in any possible environment. The standard SAE J3016, which

established the levels of driving automation, also requires defining the conditions under which driving automation is possible (ODD: Operational Design Domain) for those levels. Considering these technical hurdles, Japan could certainly not be described as well-suited for the implementation of automated driving technology due to the complexity of its traffic environments and the extreme weather differences from season to season. There is also the threat posed by the enormous research and development investments currently being made by huge foreign IT companies and other similar organizations. On the other hand, Japan still has superiority in certain areas, such as development of automobile capabilities, technical capabilities in the manufacturing of products such as sensors and cameras, and high quality control capabilities of automobiles, a product that demands safety assurance. Japan also has an over 20-year history of industry-academic-government collaborations in the ITS field, and boasts the advantage of having been the first in the world to achieve practical implementation of roadside infrestructure to vehicle and vehicle to vehicle communication systems.

In this context, Japan should adopt a strategy of pursuing industry-academic-government collaboration to a greater extent than in the past, actively create environments in which automated driving technology can be applied, obtain safety-related methods and technologies by drawing on accumulated stores of on-site practical know-how, and spread automated driving technology throughout the world—not in the form of vehicles alone, but as “systems”.

Further, Japan should work toward the realization of Society 5.0 by promoting collaboration throughout the entire automobile industry to achieve greater use and application of data, while also aiming to build an ecosystem that extends beyond the boundaries of the automobile industry. In addition to industry-academic-government collaboration, deeper collaboration will also be pursued between industry players including automobile manufacturers, component manufacturers, and service providers; between academic disciplines such as engineering, medicine, law, and urban engineering; between the central government and local government bodies; and with other fields and sectors, as well.

(h) Collaboration with local government bodies and related organization

In order to link research and development activities to commercialization efforts, the initiatives of the various diverse stakeholders must be integrated together. The second phase of SIP places a priority on practical implementation, focusing on conducting initiatives involving businesses and those affiliated with local government bodies and establishing places for conducting FOTs.

Specifically, this program sets the Olympic and Paralympic Games Tokyo 2020 as a milestone in its plan to strengthen collaborations among the national government, the Tokyo Metropolitan Government, the private sector, and others; to create a roadmap to establishing environments for demonstrations; and to draft plans for conducting FOTs. Additionally, commercialization-oriented FOTs will also be conducted for logistics and mobility services and services that provide mobility within underpopulated areas, in collaboration with businesses and those affiliated with local

government bodies.

2. Description of R&D activities

The practical implementation and deployment of automated driving requires both vehicle development and the establishment of driving environments. This project promotes development focused on cooperative areas such as the establishment of such driving environments.

General public roads are complex traffic environments, with vehicles cutting across them in addition to pedestrians, bicycles, and other types of traffic. These factors make it difficult to successfully implement automated driving at this point in time only using data from sensors and similar devices on board. Traffic environments on expressways also present difficulties for the continuous use of automated driving, such as junctions at which merging lanes are not long enough for automated-driving vehicles. Resolving these issues requires traffic signal data and merger-assistance data transmitted by infrastructure along the roads, as well as up-to-date road and traffic data using vehicle probe data. Creating this kind of data requires collaboration between the public and private sectors. Working towards the practical implementation of these technologies, the opportunity created by the Olympic and Paralympic Games Tokyo 2020 will be utilized to collaborate with the Tokyo Metropolitan Government and others to establish internationally open FOT sites. Furthermore, long-term FOTs will be promoted based on business plans that involve local government bodies and businesses, in an effort to move toward the commercialization of mobility services for underpopulated areas and the commercialization of logistics services.

Meanwhile, although the development of automated vehicles is a competitive (as opposed to cooperative) area, there are many issues that should be worked on collaboratively throughout the industry in the interest of safety. Development pertaining to these issues is required to be pursued through industry-academic-government collaboration.

The first phase of SIP focused primarily on five key issues (dynamic maps, HMI, cyber security, pedestrian accident reduction, and next-generation transport) as cooperative areas. The second phase of SIP will focus on the development of simulation tools for safety evaluations and operational tests, which will be especially important in the future, as well as research for the use and application of private vehicle probe data and other public-private road traffic data. This development work will focus on cooperative-area types of topics and feature industry-academic-government collaboration.

In pursuit of the practical implementation and deployment of services and vehicles using automated driving technology, there is a need to promote the fostering of public acceptance of the technology. This means to dispel automated driving-related misunderstandings or fears, as well as the need to make Japanese residents understand that automated driving will increase their convenience and improve their lifestyles. To this end, discussions with stakeholders, the quantification of the technology’s social and economic impact, and technological development oriented toward improving services will be pursued.

On the path to the practical implementation of automated driving, it is important to consider exits appropriate for areas and usage purposes. However, automobiles are international products and

the automobile industry is a key industry in Japan, and from that perspective there is a need to remain perpetually aware of international standardization. The project will actively disseminate SIP's results at international meetings and on the web, and lead the discussion on standardization in addition to actively promoting collaboration on joint research between Japanese and foreign research organizations.

The following four areas will be prioritized: I) The development and validation (FOTs) of automated driving systems; II) The development of core technologies for the practical implementation of automated driving; III) The fostering of the public acceptance of automated driving; and IV) The enhancing of international cooperation.

I) Development and validation (FOTs) of automated driving systems

(1) FOTs in Tokyo waterfront area

[Overview]

At present, it is difficult to realize automated driving on expressways with heavy traffic or general roads with complicated traffic environments using only the information from sensors and any similar devices on-board. Automated driving will be realized by utilizing traffic information from transportation infrastructure along the road side such as traffic data on main lane of expressway for vehicle to merge the main lane from the merging lane, traffic congestion data to plan appropriate route for automated driving, traffic signal data to drive in the crossing safely and smoothly, and other information obtained from the transportation infrastructure. FOTs (Field Operational Tests) will be conducted in Tokyo waterfront area, which has metropolitan expressways and other general public roads, connecting the Tokyo waterfront area, the Haneda Airport area, and other neighborhood areas in order to solve technical challenges to utilize the traffic environment data properly. The FOTs are conducted aiming for the acceleration of the research and development of automated vehicles, the promotion of international collaboration and standardization, the fostering of public acceptance, and research for cutting-edge technologies. Study will be accelerated toward the validation and standardization of core technologies for the practical implementation of automated driving by preparing an internationally open test environment in a real traffic environment of public roads, involving automobile manufacturers and other stakeholders. Also, toward the Olympic and Paralympic Games Tokyo 2020, events for fostering public acceptance, technological researches, and other efforts will be made.

1. Preparation and operation of transportation infrastructure for FOTs in Tokyo waterfront area

[Leaders of Research and Development] Kuniaki Okajima (Mitsubishi Electric Corporation) and Yoichi Omori (Pacific Consultants Co., Ltd.)

[Participating Bodies] Mitsubishi Electric Corporation, Pacific Consultants Co., Ltd., and NIPPO CORPORATION

[Activities]

- Develop, validate, maintain and manage transportation infrastructure in Tokyo waterfront area to provide environment necessary for FOTs in order to establish the mechanism of using traffic environmental data such as traffic signal data and traffic merger-assistance data provided by the transportation infrastructure, and to implement practical vehicle-infrastructure cooperative advanced automated driving early.

[Objectives of FY2019]

- Install ETC2.0 equipment that provides automated vehicles with merger assistance data for safe and smooth entry to expressway and open/close status data for assisting to pass ETC toll gate smoothly for the metropolitan expressways that connect the Haneda Airport, the Tokyo waterfront area, and other neighborhood areas.
- Prepare magnetic markers, Public Transport Priority System (PTPS), temporary bus stops,

dedicated lanes, and so forth that are necessary for building an automated driving system for public transportation in the Haneda Airport area (general roads).

[Mid-term objectives] (Toward the end of FY2020)

- Conduct technological validation for providing and recognizing traffic signal data necessary for the realization of automated driving, the validation of automated vehicle control technologies that use traffic signal data, the validation of the placement of transportation infrastructure devices, the validation of technologies necessary for a next-generation transportation system under a mixed-traffic environment, and other validation activities.
- Define requirements necessary for the ETC2.0 equipment to provide merger assistance and ETC toll gate passing assistance information.

2. Preparation of ITS wireless roadside devices for providing traffic signal data for FOTs in Tokyo waterfront area

[Leaders of Research and Development]

[Terminal devices] Katsuhiro Shikata (OMRON FIELD ENGINEERING Co., Ltd.)

[Center System] Kimikazu Washimi (Sumitomo Electric System Solutions Co., Ltd.)

[Participating Bodies]

[Terminal devices] OMRON FIELD ENGINEERING Co., Ltd.

[Center System] Sumitomo Electric System Solutions Co., Ltd.

[Activities]

- Prepare transportation infrastructure to provide traffic signal data for the safe and smooth control of automated vehicles in the Tokyo waterfront area.

[Objectives of FY2019] (Completed)

- Install ITS wireless roadside devices that provide traffic signal data at 38 locations in the Tokyo waterfront area.

3. Study of plans for the FOTs in Tokyo waterfront area and evaluation of data

[Leader of Research and Development] Yoshiaki Tsuda (Mitsubishi Electric Corporation)

[Participating Bodies]

Mitsubishi Electric Corporation, AISAN TECHNOLOGY CO., LTD., INCREMENT P CORPORATION, ZENRIN CO., LTD.,

TOYOTA MAPMASTER INCORPORATED, PASCO CORPORATION, Sumitomo Electric Industries, Ltd., Nippon Koei Co., Ltd., and Pacific Consultants Co., Ltd.

[Activities]

- Build a driving environment and conduct FOTs for such environment that enables safer and comfortable automated driving through cooperated automated driving technologies with transportation infrastructure that use traffic signal data, merger-assistance data, and ETC toll gate passing assistance data provided by the transportation infrastructure.

・ Promote the resolution of issues in technologies, regulations, and public acceptance to accelerate practical implementation and use through FOTs.

[Objectives of FY2019]

・ Reach an agreement with the FOT participants on the CAN input/output format used for the control of in-vehicle test devices that send and receive traffic signal data, main road merger-assistance data, ETC toll gate passing assistance data, PTPS, and so forth. Also, prototype a test in-vehicle device that the FOT participants will install for the validation of traffic signal data, main road merger-assistance data, and ETC toll gate passing assistance data, and prototype a test in-vehicle device for PTPS validation.

・ Reach an agreement with the FOT participants about the validation details (validation methods and data to be submitted), and start FOTs.

[Mid-term objectives] (Toward the end of FY2020)

・ Summarize the validation results of the FOTs to provide an interim report on the agreement with the FOT participants on the specification of the vehicle-infrastructure cooperative automated driving system, clarification of the effects (benefits) of the transportation infrastructure deployment, the placement of transportation infrastructure devices for automated driving, and positive and negative effects on the roadway traffic brought by the transportation infrastructure and automated vehicles, and so forth.

[Final goal] (Toward the end of FY2020)

・ In order to resolve issues identified through FOTs conducted in the Tokyo waterfront area toward practical implementation, conduct research on issues defined based on the achievement status in the third year (FY2020), and accomplish the goal.

(2) FOTs for the social implementation of transportation and logistics services in local regions.

[Overview]

For the commercialization of transportation and logistics services enabled by automated driving, resolve issues in securing driving space on roads and the social implementation of driving control, initially focusing on local regions with low traffic and new towns with an advanced infrastructure such as the separation of sidewalks and vehicle lanes, in which the implementation of automated driving transportation service on general roads is possible with the current technological level. Also, for the nation-wide deployment, define a guideline of the deployment of automated driving transportation services in local regions and prepare a standard of road spaces for the driving of automated vehicles. For this purpose, collaborate with local government bodies and related businesses to conduct validation aiming for defining business models that enable the sustainable operation of automated-driving-based transportation services and other types of services, as well as investigation, research, and other activities necessary for such validation. Also, study common issues with an eye on the future realization of automated driving on general roads of urban regions.

1. Preparation of an environment in local regions for the practical implementation of automated driving transportation services

[Leaders of Research and Development]

[Local regions] Seiya Hamada (General Incorporated Foundation—Highway Industry Development Organization)

[New town district] Shinichi Mizokuchi (Nippon Koei Co., Ltd.), Takekazu Inoue (The Japan Research Institute, Limited)

[Participating Bodies]

[Local regions] General Incorporated Foundation—Highway Industry Development Organization, ORIENTAL CONSULTANTS Co., Ltd., Docon Co., Ltd., Nippon Koei Co., Ltd., and Pacific Consultants Co., Ltd.

[New town districts] Consortium of Nippon Koei Co., Ltd. and DAIWA HOUSE INDUSTRY CO., LTD., Consortium of The Japan Research Institute, Limited and Keio Dentetsu Bus Co. Ltd. .

[Activities]

[Local regions]

- Collect information on the overview, technology development, and found issues of past automated driving FOTs in local regions, and organize and analyze issues and countermeasure for the social implementation of automated driving transportation services.
- Conduct a long-term FOT using automated vehicles on public roads, validate ways of solving issues toward social implementation, and prepare a deployment manual of automated driving transportation services toward social implementation.
- For the practical implementation and deployment of automated driving transportation services, conduct a long-term FOTs to collect and validate the data necessary for the initial stage of

social implementation and study issues including ways to secure driving space.

・ Conduct an FOT that directly leads to social implementation in areas that the validation of the driving environment and so forth has determined to be possible to accommodate transportation services, and also conduct a long-term FOT in areas that have a road environment difficult for automated driving but have the potential of being more efficient by using past data and so forth. Through these FOTs, collect and validate data necessary for the initial stage of social implementation, define how road spaces should be allocated for smooth driving of automated vehicles, consider standards, and so forth.

[New town districts]

・ For new town districts such as residential complexes in suburbs, in which houses were built mainly from the 1960s to 1980s and residents are rapidly aging in urban regions, summarize issues through FOTs with regard to technological constraints, technological issues, and business feasibilities, toward the construction of a public transportation system that uses automated driving technologies that contribute to the resolution of transportation issues of the residents.

[Objectives of FY2019]

[Local regions]

・ Toward social implementation, prepare a manual of the deployment of automated driving transportation services based on the current technological level.

・ In social implementation FOTs, validate business models in consideration of self-reliant operation by future business operators, which determine routes and timetables based on user records, define charging methods, grasp the driving status and reservation status, and so forth. The validation of business models also includes the provision of a system as the standard infrastructure, the impact of seasonal fluctuations on profitability, and evaluation of business plans.

[New town districts]

・ Clarify the business model and business feasibility of public transportation services provided by automated driving in suburban residential complexes, and also clarify technological constraints and issues toward social implementation.

[Mid-term objectives] (Toward the end of FY2020)

・ Realization of automated driving transportation services in local regions

・ Toward the expansion and other aspects in ODD of automated driving transportation services in local regions, resolve road environment issues and promote the fostering of public acceptance of automated driving.

[Final goal] (Toward the end of FY2020)

・ Aiming for the enhancement of services and the level of technologies including ODD to enable

the use of the services in different regions in the nation, conduct research on issues defined based on the achievement status in the third year (FY2020) to accomplish the goal.

(3) FOTs of data interrelation, focusing on road traffic environmental data related to automated driving

[Overview]

With reference to the reference architecture of Society 5.0, an architecture in the field of automated driving (hereafter referred to as "automated driving architecture") concerning geographical data is built under collaboration of public and private organizations. In order to share common views and understanding among public and private stakeholders through this automated driving architecture, the requirements and mechanisms necessary for deploying road traffic environmental data for various uses are studied through FOTs and other activities in the Tokyo waterfront area, local regions, and appropriate areas. These activities accelerate technology development, social implementation, data interrelation, international standardization, and so forth.

1. Promotion of the construction and validation projects of the automated driving architecture.

[Leaders of Research and Development] Selected through a public tender

[Participating Bodies] Selected through a public tender

[Activities]

- Build a mechanism for facilitating the matching between information owners and information users so that various users can use road traffic environmental data for different services such as the operation management and transfer guidance of transportation and logistics services based on automated driving, the search of driving routes at the time of disaster, and the provision of road congestion information based on vehicle probe data.
- Prepare data that enable such services, build a portal site that provides the one-stop viewing of the data, and conduct validation, research, development on technology issues in the Tokyo waterfront area, local regions and appropriate areas.

[Objectives of FY2019]

- Design and prototype an automated driving architecture by mapping *functions*, *data*, and *assets* onto different layers of the reference architecture model in consideration of FOTs and other activities on data interrelation in the Tokyo waterfront area, local regions, and appropriate areas, the Society 5.0 reference architecture, and many use cases,.
- Build a portal site (function) that enables the search and viewing of map and geospatial data, and prepare a draft business model for continued operation of the portal function based on the results (specification) obtained from the first phase of SIP automated driving system—*Study for Practical Implementation of Dynamic Map Service Platform*.
- Build a test database and conduct a prior validation for demonstration events to be held during opportunities such as the Olympic and Paralympic Games Tokyo 2020 in the FOTs in Tokyo waterfront area.
- Prepare test data for the interrelation of transportation and logistics services, provide an environment for the use of the data, and conduct a competitive collection of application development ideas to enable tourists and other users to use the data based on use cases that

are effective for urban residents and tourists (including foreign tourists).

- Build a test database in FOTs of automated driving transportation services in local regions, and conduct a prior validation based on use cases (service) of automated driving that can be used in small underpopulated areas in local regions.

[Mid-term objectives] (Toward the end of FY2020)

- Review the automated driving architecture and define the outline of a guideline for cross-field data utilization based on the validation results of FOTs in the Tokyo waterfront area, local regions, and appropriate areas.

[Final goal] (Toward the end of FY2022)

- Aiming for the multi-purpose deployment of the road traffic environmental data through data interrelation focused on automated driving, conduct research on issues defined based on the achievement status in the third year (FY2020) to accomplish the goal.

II) Development of core technologies for the practical implementation of automated driving

(1) Road traffic environmental data utilization technology

[Overview]

In the first phase of SIP automated driving system, a unified specification was defined mainly for high-precision 3D map data of expressways, which is essential for the realization of automated driving, and a system for developing and providing the high-precision 3D map data was established. In the second phase of SIP, for the practical implementation of more sophisticated vehicle-infrastructure cooperative automated driving on general public roads as well as expressway, research and development will be carried out on technologies of using dynamically changing road traffic environmental data that are linked to static high-precision 3D map data and are generated and digitally delivered. Related investigation and research will be also made.

1. Research and development related to the update of high-precision 3D maps based on vehicle probe data and other data

[Leaders of Research and Development] Akihiro mitoku (Dynamic Map Platform Co., Ltd.)

[Participating Bodies] Dynamic Map Platform Co., Ltd.

[Activities]

- Develop technologies of efficiently identifying locations that require the update of maps, such as the technology of identifying road change points based on vehicle probe data and the technology of mapping them onto high-precision 3D maps and identifying points to be updated through the use of the data of road changes, vehicle probe data, and other data in a coordinated manner.
- Shorten the maintenance cycle of high-precision 3D maps and reduce the maintenance cost through such development.

[Objectives of FY2019]

- Realize the technology of identifying road change points using vehicle probe data and other data.

[Mid-term objectives] (Toward the end of FY2020)

- Realize the processing of mapping road change points to a high-precision 3D map and the technology of identifying updated road points.

2. Research and development on the use of V2X data for safety assurance and other purposes under mixed-traffic environments– a simulation study on the impact of automated vehicles on traffic flow -

[Leaders of Research and Development] Kosuke Yamada (Pacific Consultants Co., Ltd.)

[Participating Bodies] Pacific Consultants Co., Ltd., UTMS Society of Japan

[Activities]

- Evaluate the impact of automated vehicle on the traffic flow, in order to consider a way to ensure traffic safety and use for traffic control and other activities, when non-automated vehicles and automated vehicles are mixed.
- Conduct traffic flow simulation and the validation of the reproducibility of current conditions, by using the data obtained from FOTs in Tokyo waterfront area under congested condition.

[Objectives of FY2019] (Completed)

- Conduct a simulation and its validation, traffic flow analysis, and other activities with an eye to the use of the data obtained from FOTs in Tokyo waterfront area.
- Consider measures to ensure traffic safety and use for traffic control and other activities.

3. Research and development for the sophistication of the technologies to provide traffic signal data and other technologies for the realization of automated driving

[Leaders of Research and Development] Shunichi Kawabe (UTMS Society of Japan)

[Participating Bodies] UTMS Society of Japan, Sumitomo Electric Industries, Ltd.

[Activities]

- Clarify the functional and technical requirements on ITS Roadside Units and traffic signal controllers that provide traffic signal data for automated vehicles, create and validate model systems, and review specifications of traffic signal information, ITS Roadside Unit and traffic signal controllers for the sophistication of the technologies to provide traffic signal data necessary for using the traffic signal data provided by ITS Roadside Units for the control of automated vehicles.

[Objectives of FY2019]

- Study the details of functional and technical requirements for ITS Roadside Units and traffic signal controllers prepared in FOTs in Tokyo waterfront area conducted from FY2021, and create and validate these devices.

[Mid-term objectives] (Toward the end of FY2020)

- Modify and validate the model systems of ITS Roadside Units and traffic signal controllers created in the year before, and review the specifications based on the validation results from FOTs in Tokyo waterfront area conducted from FY2021.

4. Research and development on the provision of traffic signal data by methods other than roadside infrastructure to vehicle communication such as communication by ITS Roadside Units

[Leaders of Research and Development] Shunichi Kawabe (UTMS Society of Japan)

[Participating Bodies] UTMS Society of Japan, OMRON SOCIAL SOLUTIONS Co., LTD., NIPPON SIGNAL CO., LTD., Panasonic System Solutions Japan Co., Ltd.

[Activities]

- Define the details of functional and technical requirements for the provision of traffic signal data by methods other than roadside infrastructure to vehicle communication such as communication

by ITS Roadside Units,

- Validate the requirements using a simulation system, and draft a specification of methods to provide traffic signal data.

[Objectives of FY2019] (Completed)

- Draft a specification of the model system to be built for FOTs conducted from FY2021

5. Research and development on the collection, integration, and delivery of data of narrow-area and mid-sized-area

[Leaders of Research and Development] Selected through a public tender

[Activities] Determined through a public tender

- Provide automated vehicles through roadside-to-vehicle communication with the information collected by the transportation infrastructure as advance notification under the situation of the transportation environment that cannot be captured by sensors and similar devices on board.
- Develop technologies related to the collection, integration, and delivery of information necessary for automated vehicles to dynamically capture the situation of the road traffic environment, define technical specifications, and validate them by FOTs for the above purpose.

[Objectives of FY2019]

- Finish the study of the test specification of the technology for collecting data to the network side, and start development.
- Finish the study of the test specification of the technology for integrating collected information and efficiently delivering it in the narrow area and mid-sized area, and start development.

[Mid-term objectives] (Toward the end of FY2020)

- Integrate the developed technologies, and, through FOTs under a real road traffic condition, define a specification that contributes to international standardization.

6 Research and development for collecting and utilizing vehicle probe data

[Leaders of Research and Development] Selected through a public tender

[Participating Bodies] Selected through a public tender

[Activities]

- Define a technical specification for the collection and utilization of traffic-lane-level roadway traffic data, and conduct an FOT for providing such data based on probe data owned by car manufacturers and car navigation system manufacturers.
- Define a specification for providing traffic-lane-level roadway traffic data in consideration of issues, points to be improved, and so forth learned from the FOTs.

[Objectives of FY2019]

- Conduct a technical study, necessary for FOTs, that covers technical methods for creating traffic-lane-level roadway traffic data from private enterprises probe data.

[Mid-term objectives] (Toward the end of FY2020)

・Build a test system that generates and provides traffic-lane-level roadway traffic data to vehicles, and validate the effectiveness of the data through an FOT by collecting and processing probe data of vehicles driving in and around the Tokyo waterfront area.

7. Research and development on recognition technologies and other technologies necessary for automated driving technology (levels 3 and 4)

[Leaders of Research and Development] Naoki Suganuma (Kanazawa University)

[Participating Bodies] Kanazawa University, Chubu University, Meijo University

[Activities]

・ Develop a test vehicle that is equipped with technologies of driving automation levels 3 and 4, clarify the technical requirements and placement requirements of the transportation infrastructure necessary for automated driving levels 3 and 4 in public roads of urban areas through FOTs conducted on public roads in the Tokyo waterfront area and other areas, and clarify the technical requirements for recognition and decisions made by the automated driving system under such transportation infrastructure.

・ Provide the opportunity of driving test vehicles to demonstrate the results of the research and development and to foster the understanding of the public on the current status of automated driving technologies in the Tokyo waterfront and other areas.

[Objectives of FY2019]

・ Equip the test vehicle with a system that can use the Quasi-Zenith Satellite System's “Michibiki” satellite and with various recognition and decision algorithms, and start a driving FOT that uses ITS wireless roadside devices that provide traffic signal data in the Tokyo waterfront area.

[Mid-term objectives] (Toward the end of FY2020)

・ Make an interim recommendation on technical requirements and placement requirements of the transportation infrastructure that provides traffic signal data based on the knowledge gained through the driving FOT on general public roads.

8. Research and development on location-based services that use the Quasi-Zenith Satellite System's "Michibiki".

[Leaders of Research and Development] Naoki Suganuma (Kanazawa University)

[Participating Bodies] Kanazawa University, Chubu University, Meijo University

[Activities]

・ Develop a localization system technology that can be applied to automated driving systems capable of driving automation levels 3 and 4 in urban areas using the information provided by the Quasi-Zenith Satellite System's "Michibiki" satellite and integrating the information with the information obtained from general sensors on board.

[Objectives of FY2019]

・ Equip the test vehicle with a receiver that can use the Quasi-Zenith Satellite System's “Michibiki” satellite and a general inertia sensor, collect sensor data in public roads in urban areas, and implement a localization algorithm. Furthermore, conduct an FOT using the Quasi-Zenith Satellite System's “Michibiki” satellite on public roads in the Tokyo waterfront area.

[Mid-term objectives] (Toward the end of FY2020)

・ Define the accuracy of location data necessary for driving automation levels 3 and 4, and make an interim recommendation on requirements on sensors and the transportation infrastructure necessary to achieve the accuracy based on the knowledge gained from the driving test.

[Final goal] (Toward the end of FY2022)

・ Check the effect of the countermeasures against issues based on the validation by FOTs conducted through to 2020, conduct research on issues defined based on the achievement status in the third year (FY2020) aiming for defining a path to social implementation of the use of roadway traffic data and other information, and accomplish the goal.

(2) Safety evaluation technologies

[Overview]

Necessary driving environment conditions cannot be configured intentionally in the current evaluation methods, which are conducted in FOTs mainly with real vehicles on public roads, so that it is difficult to determine whether automated vehicles satisfy necessary safety levels. Therefore, a method must be developed that enables the safety evaluation of automated vehicles under specific driving environment conditions. Furthermore, in order to make safety evaluation more efficient under the environment in a virtual space, which is currently conducted by real vehicles consuming enormous amounts of time in the development of automated vehicles, simulation tools and interfaces are developed and standardized mainly for the evaluation of sensor capabilities to build a virtual safety evaluation environment. By standardizing tools, interfaces, and other things developed for the virtual safety evaluation environment among related automobile manufacturers and suppliers, the level and efficiency of safety evaluation technologies of automated vehicles and systems are raised in the entire industry to reinforce the industrial competitiveness.

1. Building an environment for virtual safety evaluations

[Leaders of Research and Development] Hideo Inoue (Professor of Faculty of Creative Engineering Chair of Department of Vehicle System Engineering, Kanagawa Institute of Technology)

[Participating Bodies] Kanagawa Institute of Technology, Ritsumeikan University, MITSUBISHI PRECISION CO., LTD., SOKEN, INC., Hitachi Automotive Systems, Ltd., DENSO CORPORATION., Pioneer Corporation, Nihon Unisys, Ltd., SOLIZE Engineering Corporation.

[Activities]

- Develop 1) an *environment model* that simulates the external environment recognized by on board sensors of automated vehicles, 2) a tool that generates test data based on the evaluation scenarios, 3) *sensor models* that simulate the detection functions of real on board sensors, which are cameras, millimeter-wave radar, and LiDAR, 4) an *automated driving model* that simulates movement control of automated vehicles based on the information detected by sensors, and other functions in order to build a virtual safety evaluation environment through industry-academia collaboration.
- Define and standardize module interfaces for the building of virtual safety evaluation environment to enable the use of the developed models and tools as add-on modules.

[Objectives of FY2019]

- Study the environment model, sensor model, and automated driving model, and other models necessary for safety evaluation, design and integrate the simulation and interfaces with an eye to standardization, and check basic behaviors of function simulation.

[Mid-term objectives] (Toward the end of FY2020)

- Validate the possibility of evaluating sensor problems and performance limitations through more detailed physical simulation based on developed models and other items.

[Final goal] (Toward the end of FY2020)

- To validate the possibility of the evaluation in general roads and other driving environments, conduct research on issues defined based on the achievement status in the third year (FY2020) to accomplish the goal.

(3) Other core technologies

[Overview]

For driving automation level 4, investigation is conducted on how the HMI should be for the communication between automated vehicles and surrounding parties in the traffic (pedestrians, riders of bicycles, drivers of vehicles, etc.) and between automated vehicles and their drivers in consideration of worldwide trends, appropriate display, and training methods. Necessary technologies are developed and the preparation of a guideline and so forth are considered.

Also, while new cyber-attack methods are always emerging, investigate cyber security and other aspects including the automatic update of vehicle driving system software over the network. the development of necessary technologies, the preparation of a guideline, and other activities are conducted. Research and development on core technologies necessary for automated driving is also conducted.

1. Research on HMI and others in accordance with the sophistication of automated driving

[Leaders of Research and Development] Selected through a public tender

[Participating Bodies] Selected through a public tender

[Activities]

- Ensure the safety of automated vehicles and surrounding parties in the traffic (pedestrians, riders of bicycles, drivers of vehicles, etc.) and consider reassuring and smooth communication methods with which communicating parties understand each other's intention with an eye to transportation and logistics services by automated vehicles of driving automation level 4 to provide transportation means and supplement insufficient drivers in underpopulated areas.
- Develop an HMI for appropriately conducting driving handover to the driver and other operations in case of abnormal driving environment conditions or the degradation of automated driving system functions, and consider training methods for drivers.
- Derive the knowledge that drivers and pedestrians should learn, and consider effective methods of training them for automated vehicles of driving automation levels 3 and 4 and driver-assistance systems of level 2 that are spreading.

[Objectives of FY2019]

- Provide an organized description of causes and conditions triggering miscommunication in situations that involve multiple traffic participants about communication using an outward HMI.
- Build a test environment for reproducing situations in which driving handover and the like happen.
- Formulate a hypothesis on driving training for automated vehicles of driving automation level 3, and prototype a driving training material based on validation using a driving simulator.

[Mid-term objectives] (Toward the end of FY2020)

- Draft communication methods that use an outward HMI and countermeasures against

negative effects of using such HMI.

- Develop a method of quantitatively evaluating impacts on driving handover and other operations and an HMI that enables appropriate driving handover and other operations
- Conduct a real-vehicle validation of driving training for automated vehicles of driving automation level 3, and start a trial in driving training institutions such as driving schools.

2. Investigation and research for countermeasures against new cyber-attack methods

[Leaders of Research and Development] Selected through a public tender

[Participating Bodies] Selected through a public tender

[Activities]

- Investigate the trend of new cyber-attack methods and countermeasures, taking into account that Intrusion Detection Systems (IDS), which detect attacks on vehicles from malicious third parties, are drawing attention as after-sales countermeasures for vehicles while new cyber-attack methods on vehicles are continued to be reported in international conferences and the like.
- Collaborate with vehicle cyber security standardization bodies and other organizations, and consider a technical standard (draft) for combating new cyber-attack methods.

[Objectives of FY2019] (Completed)

- Write a technical standard (draft) for combating new cyber-attack methods.

[Final goal] (toward the end of FY2022)

- Aiming for defining requirements on the HMI in accordance with the sophistication of automated driving and for writing a cyber security guideline covering software update, conduct research on issues defined based on the achievement status in the third year (FY2020) to accomplish the goal.

III) Fostering of public acceptance of automated driving

(1) Delivery of information to the public and fostering of understanding

[Overview]

With an eye to future social implementation and acceptance of automated driving, how information should be delivered to the public is considered and a strategy of delivering information about the social system and technologies for automated driving to foster public acceptance of automated driving are formulated. Interactive events involving residents, local government staff, related businesses, and others are held, in consideration of the needs and road traffic environment of each local area, and the study of new transportation services are accelerated. Through dialogue and communication with the public, both overconfidence in and distrust of automated driving are rectified to promote correct understanding.

1. Formulation and evaluation of strategy for fostering public acceptance

[Leaders of Research and Development] Selected through a public tender

[Participating Bodies] Selected through a public tender

[Activities]

- Formulate a overall strategy including public relations for fostering public acceptance in order to foster the awareness and correct understanding of automated driving by clarifying not only benefits and effects of automated driving but also their risks for traffic participants to foster the total public understanding of automated driving including a future landscape and rules.
- Consider proper materials that contribute to the correct understanding of automated driving, effective manners of public relations, and methods of measuring effects.
- Measure the effects of activities conducted based on the strategy, evaluate them, and review the strategy as necessary.

[Objectives of FY2019]

- Formulate a overall strategy of fostering public acceptance toward the end of FY2020.

[Mid-term objectives] (Toward the end of FY2020)

- Review the total strategy to formulate a total strategy for a period starting from FY2021 based on the measurement results of the effect of the activities conducted based on the strategy and their evaluation.

2. Planning and promoting events during automated driving FOTs and other opportunities for citizens, local government staff, and related businesses, etc.

[Leaders of Research and Development] Selected through a public tender

[Participating Bodies] Selected through a public tender

[Activities]

- Conduct activities for fostering overall social awareness and providing correct understanding. For example, foster the public understanding using webs, social networking services (SNS),

and other media that many users of transportation services have access to.

- Conduct public relations events including interactive ones as well as public participatory events during FOTs in the Tokyo waterfront area, and also conduct activities for fostering the understanding and awareness of automated driving for those that do not use automated driving.
- Hold collaborative events with various institutions of the industrial sector to promote the correct understanding of the social needs and effectiveness of automated driving as well as the introduction of new automated-driving-based transportation services aiming for the penetration of automated driving in society.
- Hold interactive events involving the public, local government staff, and related businesses in consideration of the road traffic environment and needs of each local area to accelerate the study of new transportation services. Through dialogue and communication with the public, rectify both overconfidence in and distrust of automated driving to promote correct understanding.

[Objectives of FY2019]

- Provide the public with easy-to-understand explanatory materials. Also, conduct public relations events, events that the public can participate in, collaborative events with various institutions of the industrial sector, and other events during FOTs in the Tokyo waterfront area to promote the understanding and awareness of automated driving.
- Hold interactive events involving residents, local government staff, related businesses, and others, in consideration of the needs and road traffic environment of each local area.

[Mid-term objectives] (Toward the end of FY2020)

- Conduct activities for promoting the correct understanding of automated driving taking advantage of FOTs of the Tokyo waterfront area on the occasion of the Olympic and Paralympic Games Tokyo 2020.
- Hold interactive events involving the public, local government staff, and related businesses in consideration of the transportation environment and needs of each local area to accelerate the study of new transportation services.

[Final goal] (toward the end of FY2022)

- Aiming for the acceleration of social implementation of automated driving services through the continued effort of fostering public acceptance, accomplish the goal defined based on the achievement status in the third year (FY2020).

(2) Investigation and research for the resolution of social issues by automated driving technologies

[Overview]

First presenting the context within a long-term vision of Japan, the impact of automated driving on reducing traffic accidents, cutting CO2 emissions, changing traffic congestion, and other factors, are organized and quantitatively expressed based on trends such as the level of the automated driving technology and the state of its propagation. Materials are provided for open discussion on the utility and potential risks of automated driving.

Also works are conducted to build an industry-academic-government collaborative framework connecting organizations, industries, and disciplines beyond what currently exists, with the aim of organizing an ecosystem for the practical implementation of automated driving.

For the realization of transportation services that transportation-impaired people (aged, disabled, pregnant people, foreign tourists, etc.) can use at rest, different needs are investigated and investigation and research in the hardware and software aspects of the potential use of optimum automated driving technologies are conducted. Also, through the technical validation of driver assistance for people with visual and other disabilities, the effectiveness of the safety-drive-assistance system quantitatively evaluated based on automated driving and publicized. Furthermore, investigation, research, and other activities necessary for resolving social issues by automated driving are conducted.

1. Evaluation of impacts of automated driving on the reduction of traffic accidents

[Leaders of Research and Development] Yoshihiro Suda (The University of Tokyo), Hiroaki Miyoshi (Doshisha University)

[Participating Bodies] The University of Tokyo, Doshisha University

[Activities]

- Sort out the relationship between automated driving and SDGs, and forecast the penetration rates of different automated driving technologies through to 2050. Then, estimate the impact on the reduction of traffic accidents, CO2 emission, traffic congestion, and other aspects, sort out the impact on the transportation service field, industrial fields, and sociological fields, and provide a quantitative forecast.
- Conduct collaborative research and other activities with overseas research institutions including those in the United States and European nations about the fostering of public acceptance.

[Objectives of FY2019]

- Sort out the relationship between automated driving and SDGs, and formulate a guideline of activities for fostering public acceptance.
- Forecast the penetration rates of different automated driving technologies through to 2050, which will be common reference values for analyzing different impacts. Based on the estimation, sort out the impact on the reduction of traffic accidents, CO2 emission, traffic congestion, and

other aspects, and provide a quantitative estimation.

[Mid-term objectives] (Toward the end of FY2020)

- Sort out preconditions necessary for making a forecast such as different statistics and information collected from the industry, and then sort out the impact on the transportation service field, industrial fields, and sociological fields and provide a quantitative forecast.

2. Sophisticated driver-assistance system for those with vision disturbance or other handicaps

[Leaders of Research and Development] Masayo Takahashi (Project leader of Laboratory for Retinal Regeneration, RIKEN Center for Biosystems Dynamics Research)

[Participating Bodies] Nagoya University, University of Tsukuba, Kobe City Eye Hospital, Tohoku University, Niigata University

[Activities]

- Collect data of driving behaviors of visually impaired and unimpaired people using a simple driving simulator used in ophthalmic clinics, and identify causes of accidents specific to people with vision disturbance of different sites and severities.
- Identify driver-assistance functions that are truly useful for people with vision impairment, implement such functions in a driving simulator to validate their effectiveness for the reduction of accidents.
- Establish a methodology for ensuring the safety of people with vision impairment through the use of driver-assistance systems, and formulate a guideline for the design of driver-assistance systems.

[Objectives of FY2019]

- Give a comprehensive consideration on the relationship between the movement of the line of sight and the behavior of vehicles driven by visually impaired and unimpaired people based on the driving simulator data and clinical findings, and then build a database.
- Identify the conditions for driver-assistance systems to enable people with vision impairment to avoid accidents on the same level as unimpaired people.

[Mid-term objectives] (Toward the end of FY2020)

- Identify issues of driver-assistance systems used by people with vision impairment, and formulate a design guideline of driver-assistance systems that contributes to the reduction of accidents.

[Final goal] (Toward the end of FY2022)

- Accomplish the goal defined based on the achievement status in the third year (FY2020), aiming for the evaluation of the impact on the reduction of traffic accidents, CO2 emission, and traffic congestion and the clarification of the effects and risks that automated driving will bring through the support for transportation-impaired people, based on a long-term vision that

considers the trends of technological levels and the automated driving penetration.

IV) Enhancement of international cooperation

[Overview]

In order to maintain the international competitiveness of the automobile industry and related industries in Japan, Japan must take initiative in standardization activities of automated driving to achieve international accord. Japan will proactively deliver information to create opportunities for internationally open research, development, and social implementation of automated driving, and will conduct investigation, research, and other activities necessary for the enhancing of international cooperation through standardization and joint research.

1. Delivery of information to the world through SIP-adus Workshop (international workshop) and other opportunities

[Leaders of Research and Development] Yoichi Onagi (Congress Corporation)

[Participating Bodies] Congress Corporation

[Activities]

- Delivers information actively on FOTs, research and development, and other activities of automated driving in Japan through websites and international workshops; especially, deliver information on FOTs in Tokyo waterfront area and demonstration events, which provide internationally open environments for research and development, in order to strengthen the capability of information delivery from Japan for purposes of strengthening the initiative of Japan in the research and development of automated driving, the seeking of technologies originated from Japan, the harmonization of international standardization and other activities, and the promotion of international cooperation through joint research and other activities.

[Objectives of FY2019]

- Hold international workshops continuously in Tokyo that will trigger activities for international standardization and new international joint research, involving participants of key people from the United States, European nations, and other nations to deliver information on research, development, and other activities in Japan for automated driving.
- Deliver information on the results of research, development, FOTs, and other activities using websites and other media.

[Mid-term objectives] (Toward the end of FY2020)

- Review the information delivery and other activities in 2019, and continue information delivery, international workshops, and other activities for the enhancing of international cooperation through activities of standardization and joint research.

2. Promotion of joint research in automated driving with overseas research organizations

[Leaders of Research and Development] Yoshimasa Suda (Director of Mobility Innovation Collaborative Research Organization, The University of Tokyo)

[Participating Bodies] The University of Tokyo

[Activities]

- Establish a corporation environment, define cooperation themes, and conduct other activities through industry-academia-government collaboration, and reinforce the database for automated driving research conducted mainly in Japan in order to promote international cooperation through international joint research with foreign research institutions of automated driving.
- Work to establish a sustainable organization that maintains dialogue with foreign industry-academia-government collaborative research institutions and is capable of handling Japan specific issues.

[Objectives of FY2019]

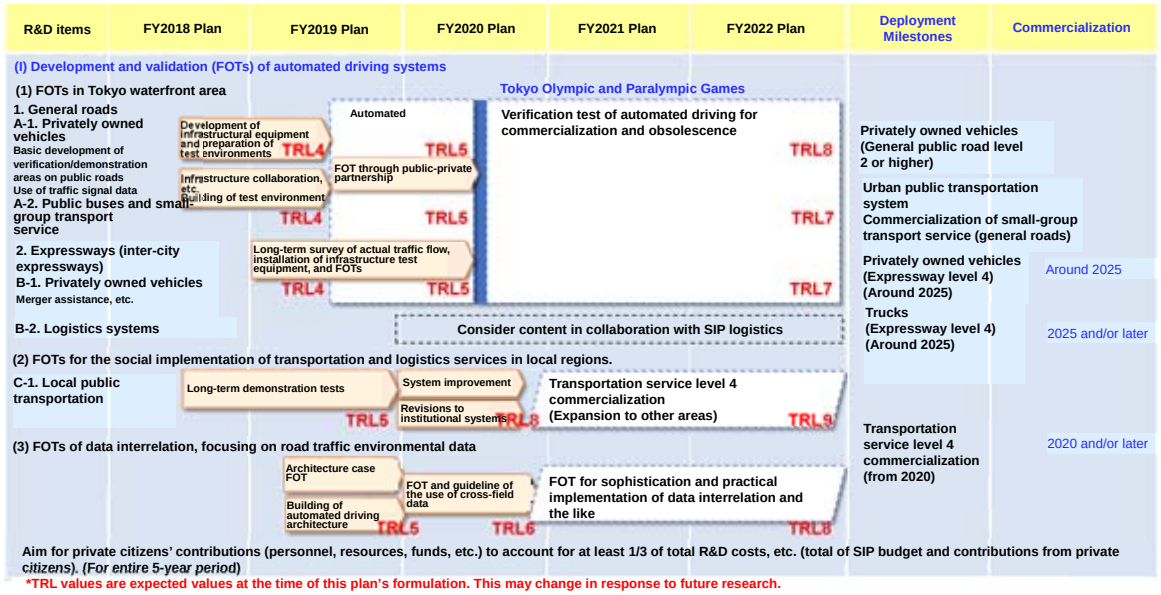
- Hold expert workshops and to define research themes in order to promote international cooperation with research institutions in the United States, European nations, and other nations.
- Reinforce the database through the investigation of themes of research, development, and FOTs, and other information from Universities and research institutions in Japan.
- Conduct a trial process of coordinating research fields and schemes during international cooperation activities, as well as a trial process by which experts define joint research themes.

[Mid-term objectives] (Toward the end of FY2020)

- Provide an organized description of the processes of coordinating research fields and schemes and defining research themes.
- Provide an organized description of academic and technical fields of automated driving, opportunities of international cooperation, incentives that promote international cooperation. And then, study a sustainable international cooperation model and provide a recommendation as an interim report

[Final goal] (Toward the end of FY2022)

- As for international standardization, accomplish the goal defined based on the achievement status in the third year (FY2020), aiming for establishing a sustainable organization for international cooperation and for maintaining the leadership in standardization activities, through the promotion of de fact and de jure standards with close collaboration with the Japan Automobile Manufacturers Association, the Society of Automotive Engineers of Japan, and other organizations as well as through the promotion of joint research on automated driving with research institutions in the United States, European nations, and other nations.



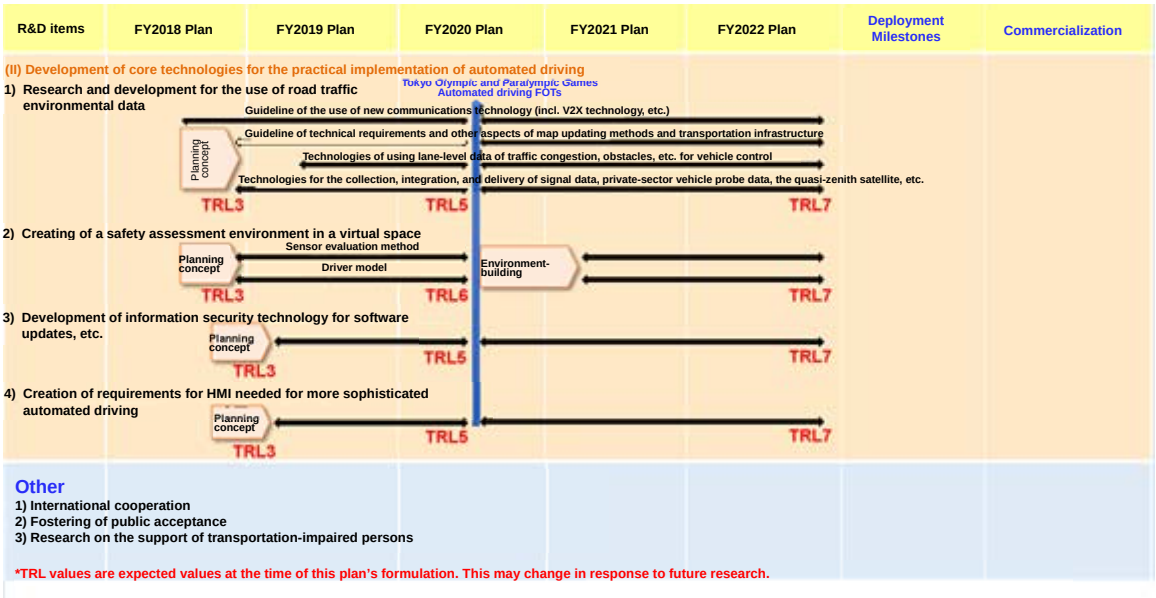


Fig. 2-1. R&D Roadmap

SIP Phase Two: TRL definitions for automated driving

TRL: Technology Readiness Level

	TRL	Definition
Foundational research	1	Basic scientific principles or phenomena discovered
	2	Formularization of the basic principles or phenomena; applied research
Practical research, development	3	Confirmation of the technology concept
	4	Laboratory testing
	5	Testing in a hypothesized use setting
Verification	6	Verification/Demonstration (system level)
	7	Top user test (system level)
Commercialization	8	Pilot run
	9	Mass production

SIP can handle up through TRL 7. TRL 8-9 are developed by the business world.

3. Implementation structure

(1) Project management by NEDO

This project is managed by NEDO with subsidies from Cabinet office. NEDO implements the promoting framework shown in Figure 3-1. NEDO assists the PD and Steering Committee to study research and development plans, manage research and development progress and budgeting, support administrative work for review projects, make evaluation materials, conduct relevant studies and analysis, etc.

(2) Selection of the leader of the project

Based on this plan, NEDO selects, via public call for proposal, research and development project and the leader of the projects who will pursue these projects. The Screening criteria and methods used by screeners are decided by NEDO in consultation with the PD, Cabinet Office, related government agencies and ministries responsible for the project, and the Steering Committee. No parties with an interest in the researchers participating in the application shall participate in the screening of that application. The definition of “party with an interest” shall be determined by NEDO.

(3) Methods of optimizing the research framework

The practical implementation of automated driving requires not only technical work with respect to the vehicles but also work on regulatory systems and traffic information infrastructures. Moreover, collaboration is required to among government agencies and ministries, and industry, academia, and the government in order to build traffic environment data, such as traffic signal data, roadway regulations data, and other data. The relationships of mutual trust built up in the first phase of SIP is maintained, while aiming for even further accomplishments in the second phase of SIP, deepening cross-disciplinary initiatives, and developing an industry-academic-government collaborative framework that extends throughout Japan. Collaborations will be actively sought with foreign projects and the initiative taken in promoting international cooperation and standardization strategies.

The second phase of SIP starts from February 2019 with renewed organizations of Steering Committee members, subordinate working groups, task forces, etc., as well as the System Implementation Working Group (WG), Business Promotion Working Group (WG), and International Cooperation Working Group (WG). Under the System Implementation Working Group (WG), the activities of FOTs in the Tokyo waterfront area Task Force (TF) will also continue to plan FOTs in the Tokyo waterfront area. Under the Business Promotion Working Group (WG), the Traffic Information Infrastructure Task Force (TF) is newly established, which will study how to build and use road traffic environmental data.

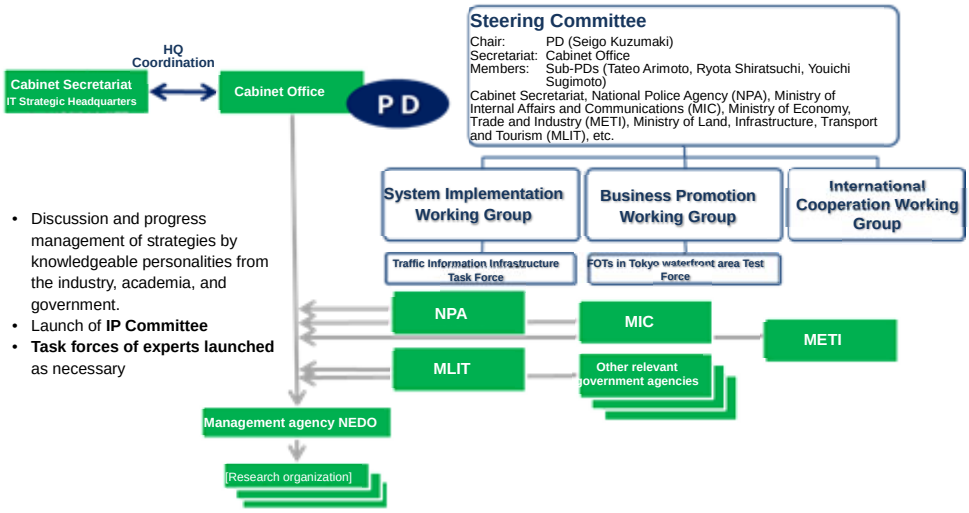


Figure 3-1. Implementation structure

(4) Collaboration among government agencies and ministries

The practical implementation of automated driving requires not only technical work with respect to the vehicles but also work on regulatory systems and traffic information infrastructures. Moreover, collaboration is required among government agencies, and ministries, and among industry, academia, and the government in order to build traffic environment information, such as traffic signal data, roadway regulations data, and other data. Relationships of mutual trust built up in the first phase of SIP will be maintained while deepening cross-disciplinary initiatives.

(5) Expectations of contributions from the business sector

The business sector will be encouraged to invest in automated vehicles and evaluation staff, and then the program will develop and pursue practical implementation plans for legacy-oriented products.

Future contributions (including both human resources and material contributions) from the business sector are expected to exceed 1/3 of the total value of expenditure for research and development and related activities (i.e. the total of contributions from both the national government and the business sector). (For entire 5-year period)

4. Intellectual properties and their evaluation

Intellectual properties and their evaluations are handled based on the Guidelines for the Cross-ministerial Strategic Innovation Promotion Program (determined by Governing Board, CSTI).

5. Deployment Milestones

(1) Deployment milestones for research implementation

This program sets the Olympic and Paralympic Games Tokyo 2020 as a milestone in its aim to overcome three barriers to implementation through industry-academic-government collaboration:

developing the technology, the regulatory framework, and the public acceptance required. This work will be conducted in combination with infrastructural technology development and FOTs in the Tokyo waterfront area, local regions, and elsewhere. These FOTs will promote investment through the participation of automobile companies, businesses, local government bodies, and other parties to help achieve implementation and commercialization of the technology. Moreover, the active use for a variety of purposes of maps and geographical data created to support automated and advanced driving technologies will be promoted to contribute to the achievement of Society 5.0.

a. The opportunity of the Olympic and Paralympic Games Tokyo 2020

SIP-adus uses the preparatory period leading up to the Olympic and Paralympic Games Tokyo 2020 to take advantage of the attention and opportunities presented by the games. FOTs in the Tokyo waterfront area will be conducted to promote Japanese technology to the world by collaborating with the Japan Automobile Manufacturers Association.

b. FOTs planning and administration that involves businesses and local government bodies

Commercialization-oriented FOTs will be conducted for logistics and transportation services and services that provide mobility within underpopulated areas, in collaboration with businesses, local government bodies, and other relevant parties.

c. Enhancement of working with other SIP projects

High-precision 3D map data, road traffic data, and vehicle probe data created and collected for automated driving can be expected to be useful to a variety of other industries in addition to the automobile industry. SIP-adus works to link up with other SIP projects (security, etc.) while building a framework whereby these types of data can be distributed in a safer and easier-to-use format. SIP-adus aims for the on-going commercialization of data creation.

Additionally, SIP-adus will collaborate with SIP logistics on automated-driving research for logistics services, and plan out research and development projects and FOTs after sufficient discussion regarding needs and deployment milestone.

d. Selection of clients and private-sector parties to which to transfer research results and technology

The project conducts research and development on topics that fall within cooperative areas (as opposed to competitive areas). For that reason, it is assumed that the work of this project will be inherited by an organization of a public nature. Research results and technology will be transferred to an existing public organization or a private company invested in by several companies, such as DMP (Dynamic Map Platform Co., Ltd.), which was established in the first phase of SIP. Additionally, research results will also be reflected in actual products by making results pertaining to cyber security, HMI, and other vehicle structure-related areas into industry guidelines.

(2) Promoting measures

In order to promote the implementation of automated driving technology, it is important to foster public acceptance of automated driving technology. Initiatives will work to clarify the value of and issues with automated driving, and to have general citizens develop a correct understanding of it, in addition to carrying out research to improve services. International standardization will be pursued through international cooperation with that aim of seeing the R&D output of this project put to use in the global market.

a. Increase awareness by utilizing the opportunity presented by the Olympic and Paralympic Games Tokyo 2020
b. Plan and establish places for dialogue with residents alongside FOTs in the Tokyo waterfront area and local regions
c. Promote research and development on and practical implementation of services oriented toward the implementation of automated driving

6. Other important items

(1) Legal basis and related topics

This project is implemented based on the following: Act for Establishment of the Cabinet Office (Act No. 89 of 1999) Art. 4-3(7)3; Basic Policy on the Costs of Creating Innovation in Science and Technology (May 23, 2014; Council for Science, Technology and Innovation); Implementation Policy for the Costs of Creating Innovation in Science and Technology (May 23, 2014; Council for Science, Technology and Innovation); Guidelines for the Cross-ministerial Strategic Innovation Promotion Program (May 23, 2014; Governing Board, Council for Science, Technology and Innovation); and National Research and Development Agency Act on the New Energy and Industrial Technology Development Organization, Art. 15-2.

(2) Review and Revise of the Plan

This plan shall be revised as required in the interest of maximizing and accelerating achievement of results.

(3) PD and assigned personnel

(a) PD

Seigo Kuzumaki
(April 2018
–)

(b) Assigned directors (Counsellors)

Takao Nitta
Leader/Director
(April 2018
- June 2019)

Naohiko Kakimi
Sub-leader
(April 2018
–June 2019)

Yoshihiro Izawa
Counsellor
(April 2018
–July 2018)

Yasuyuki Koga
Counsellor
(August 2018 –
June 2019)
Leader
(July 2019–)

Kenji Ueki
Sub-leader
（July 2019–）

(c) Assigned personnel

Masaki Chikuma
(April 2018
–March 2019)

Kaoru Sugie
(April 2018
–March 2019)

Yukiko Hatazaki
(October 2018
–)

Kazuya Murata
(April 2019
–)

Toshikazu Tanaka
(April 2019
–)

Appendix: Funding plan and estimates

(Units used below: Millions of yen)

FY2018 total: 3,000

(Subtotals)

1. Total budget for R&D and related activities (incl. administrative costs, indirect expenses)	2,884
(Subtotal for each research and development item)	
[I] Development and validation (FOTs) of automated driving systems	1,820
(Related government agencies and ministries: NPA; MIC; METI; MLIT; etc.)	
[II] Development of core technologies for the practical implementation of automated driving	896
(Related government agencies and ministries: NPA; M C; METI; MLIT; etc.)	
[III] Fostering of public acceptance of automated driving	50
(Relevant government agencies and ministries: NPA; MIC; METI; MLIT; etc.)	
[IV] Enhancement of international cooperation	118
(Relevant government agencies and ministries: NPA; MIC; METI; ML IT; etc.)	
2. Budget for support of the project (Personnel expenses, evaluation expenses, meeting expenses, etc.)	116

FY2019 total: 3,520 (including a supplementary budget)

(Subtotals)

1. Total budget for R&D and related activities (incl. administrative costs, indirect expenses)	3,404
(Subtotal for each research and development item)	
[I] Development and validation (FOTs) of automated driving systems	1,004
(Related government agencies and ministries: NPA; MIC; METI; MLIT; etc.)	
[II] Development of core technologies for the practical implementation of automated driving	2,007
(Relevant government agencies and ministries: NPA; MIC; METI; ML IT; etc.)	
[III] Fostering of public acceptance of automated driving	213
(Relevant government agencies and ministries: NPA; MIC; METI; MLIT; etc.)	
[IV] Enhancement of international cooperation	180
(Relevant government agencies and ministries: NPA; MIC; METI; MLIT; etc.)	
2. Budget for support of the project (Personnel expenses, evaluation expenses, meeting expenses, etc.)	116