Public-Private ITS Initiative/Roadmaps 2019

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Strategic Conference for the Advancement of Utilizing Public and Private Sector Data, Strategic Headquarters for the Advanced Information and Telecommunications Network Society

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1 Introduction

(1) Introduction

The collective term “Intelligent Transport Systems” (“ITS”) means new road transport systems designed to integrate people, roads, and vehicles via cutting-edge information and communications technology to enhance the safety, transport efficiency, and comfort of road transport, and the systems devoted to improving the safety and convenience of road transport.

In recent years, ITS, in particular automated driving systems, has been experiencing significant innovations due to the development of information technology (IT) and progress in the use of data. In particular, since June 2013 when Declaration to Be the World’s Most Advanced IT Nation was announced by the Japanese government, many domestic and overseas manufacturers have conducted demonstrations of automated driving systems and field operational tests on public roads. As can be seen by the fact that nations around the world have also been announcing policies regarding automated driving, it seems that the era of global competition over the practical application and popularization of automated driving systems has set in. In the midst of this global context, the government of Japan has promoted public-private partnership-based research and development under the Cross-ministerial Strategic Innovation Promotion Program by the Council for Science, Technology and Innovation (hereinafter referred to as "SIP"): Automated Driving for Universal Service (SIP-adus) (herein after referred to as “first phase of SIP-adus”) from fiscal 2014 to 2018. Since 2018, the partnership has been engaged in research and development, field operational testing, etc. under the newly launched the second phase of Cross-ministerial Strategic Innovation Promotion Program - Automated Driving for Universal Service (SIP-adus) (herein after referred to as “second phase of SIP-adus”)[1].

Until now, Japan has maintained the world's highest level of technology in an automobile industry that is the largest export industry in Japan while also maintaining the world's most advanced level of ITS-related national infrastructure. However, in the midst of the significant global innovation in ITS, it is no longer easy for Japan to maintain its relatively high competitive edge.

The whole society of Japan aims to acutely respond to this innovation wave, continue building and maintaining the world's most advanced ITS, and develop and implement strategies through

1 A determination was made in the New Package of Economic Policies (as approved by the Cabinet in December 2017) to commence the following SIP, whose start date was slated for FY2019, ahead of schedule. At the general conference of the CSTI subsequently held on March 29 (general science, technology, and innovations conference), twelve issues—including automated driving—were formally adopted.

collaboration between the public and private sectors to allow its people to enjoy the fruits of the world's best road transport that society can offer.

By doing so, Japan aims to build and maintain the world's best ITS and thereby contribute to its people and the world.

With this as an objective, Japan has developed and revised Public-Private ITS Initiative/Roadmaps five times since June 2014 and will continue to pursue this objective.

The development of Public-Private ITS Initiative/Roadmaps has led to the sharing of the future direction among ITS-related ministries, agencies, and private companies; the promotion of specific collaboration among related ministries and agencies; and the encouragement of competition and cooperation among private companies. In particular, a system to enable field operational tests of driverless automated driving transport services on public roads in specified areas has been developed and demonstration projects have been implemented in regions across the country, and companies that are involved in the development of high-precision three-dimensional maps constituting static information as a subset of the dynamic maps underpinning the first phase of SIP-adus large-scale field operational tests of automated driving on expressways, which started in FY2017 and ran through the end of 2018, have been established in cooperation with private-sector enterprises. In addition to expanding the practical application of automated driving to ordinary roads in 2018, second phase of SIP-adus was started for the purpose of commercializing logistics and transport services utilizing automated driving technologies.

On the other hand, technologies and industries related to ITS including automated driving systems (hereinafter referred to as "ITS/Automated Driving" to clearly state that it includes automated driving) have been making rapid progress. In particular, as the structure by which data are distributed changes with the evolution of the Internet of Things (IoT), artificial intelligence (AI) – which utilizes such data as an infrastructural element – is important for the development of recognition and judgment technologies. In addition, domestic and foreign emerging automakers companies such as automakers and emerging IT companies have announced their efforts for the commercialization of highly automated driving and competition in development is becoming increasingly intense. Meanwhile, some countries and regions have begun considering the improvement of legal system for the commercialization of highly automated driving.

The "Public-Private ITS Initiative/Roadmaps 2019" (hereinafter, "Initiative/Roadmaps") developed as a radical revision of Public-Private ITS Initiative/Roadmaps 2018 after discussing recent changes in the situation surrounding ITS and automated driving in the meetings of the Road Transport Working Group, New Strategies Promotion Expert Panel, IT Strategic Headquarters,

including joint meetings with the SIP-adus Promotion Committee, which have been held since December 2018.

(2) Social issues surrounding road transport

Against a backdrop of changes in the social structure beginning with the declining birth rate and aging population as well as the concentration of the population in urban areas, Japan is currently facing concerns that various social problems surrounding road transport may become more severe.

For example, it is projected that the ratio of traffic accidents involving the elderly drivers will further increase as the rate of aging, which is already the world's highest, is expected to rise further. In addition, there is a risk that the decreasing and declining population, particularly in regional areas which are expected to experience an increase in aging, may lead to a combination of factors such as a decrease in the demand for public transportation, financial pressure on the local transportation business operators and local public bodies as a result, and the further lack of drivers may make it even more difficult to maintain regional public traffic networks and expand the areas where no transportation is available. Because of this, there is a risk that securing the means of transportation for poor mobility environment including elderly citizens who have turned in their driver's license, may surface as a more serious problem.

On the other hand, if traffic jams and crowding occur against a backdrop of further centralization in economic activity and population and an increase in inbound demand, particularly in the urban areas centered in the three major metropolitan areas, they may lead to economic losses and environmental problems such as global warming.

Moreover, in the logistics field, the demand for distribution is projected to increase due to the further expansion of e-commerce going forward as the problem of a shortage of truck drivers is already becoming apparent, and the response to the shortage of logistics carriers is considered to be a pressing issue as the industry is currently dependent on middle-aged drivers.

(3) Future vision of automated driving and mobility services

A. Problem-solving approach

The application of new technologies holds the key to solving the problems described above. It is expected that the application of AI, IoT, and other technologies will upgrade mobility systems including mass transportation and distribution while also integrating automated driving technologies in the future so that solutions to the problems faced by the road transport field in Japan may start to develop in earnest. In order to do so, it is important that the public and private sectors work together

to examine the activation of new mobility services and the social implementation of automated driving not as separate initiatives but as elements which are closely connected for problem-solving.

B. The vision of society realized through automated driving

Automated driving technologies, which are rapidly evolving, are expected to enable driving that is safer and smoother than what can be accomplished by human drivers and to someday solve various road transport-related issues affecting Japan.

For instance, we can expect to offer safer, more comfortable transport options for the elderly drivers by bolstering driving operations and safety checks, reducing traffic accidents involving the elderly drivers by commercializing automatic driving vehicles that provide automated driving transport services, promoting circumstances to facilitate safe driving on a continuous basis even for elderly drivers, and carrying out other such initiatives.

In aging regions, hilly and mountainous areas, decrepit large-scale housing complexes that were developed during the high-growth period of the Japanese economy (superannuated satellite towns), and other areas being depopulated as residents age, the creation of new transport services through automated driving vehicles can be expected to secure means of transportation.

In addition, the implementation of automated driving vehicles in distribution services can be expected to solve the driver shortage problem by reducing the burden placed on drivers and reducing the number of drivers that are needed.

In this way, automatic driving technologies can be expected to solve a large number of issues relating to road transport in Japan. In addition, the commercialization of automated driving vehicles should lead to the followings:

i. Realizing a safer, smoother road transport society by reducing traffic accidents and relieving traffic congestion

The ability to move from place to place safely and securely and to do so under smooth, comfortable conditions is the ongoing dream of many people. If we accept that most traffic accidents can be attributed to mistakes made by human drivers, we can expect to see a significant reduction in the number of traffic accidents as automated driving vehicles become more widespread. Traffic congestion on expressways is often caused when the smooth flow of traffic is disrupted as the velocity of vehicles naturally drops on upward slopes and at other such locations, thereby causing the interval between vehicles to shrink and drivers in trailing vehicles to step on their brakes. However, traffic congestion will likely be eased, thanks in part to the spread of automated driving vehicles and the adoption of vehicle-to-vehicle communications and vehicle-to-infrastructure communications. The

easing of congestion and the promotion of smooth traffic will give rise not only to a driving environment that is comfortable for drivers but also to a traffic environment that can enable trucks tasked with accommodating the steep increase in demand for the logistics of goods to ship items rapidly and on time. This can lead to the streamlining of the logistics of goods and to a favorable impact on the shipping of perishable foodstuff and other such products whose quality is determined to a considerable extent by transit duration.

ii. Creating a new mobility service industries to provide finely-tuned transport services

The utilization of automated driving vehicles is expected to lead to the spread of various new finely-tuned services. For example, incorporating tourism data on nearby sites into automated driving vehicles can provide new transport services for tourism. Delegating to automated driving vehicles the task of bringing children, who have no drivers' licenses, to and from locations can reduce the burden on guardians. When going on a shopping excursion, you can avoid having to look for a parking spot and instead simply drop off your vehicle and determine a pick-up time to have yourself picked up by an automated driving vehicle after you complete your shopping tasks. It is expected that these sorts of services will become widespread, new services based on the use of automated driving vehicles will be created, and the ways in which travel time is spent for different patterns of life and lifestyles themselves will transform significantly. New sectors providing such services will likely evolve as growth sectors helping to create new ways of living for the future.

iii. Rural revitalization in Japan as made possible by automated driving vehicles

While regional revitalization is vital for the growth of the Japanese economy, the economy is actually beset by many issues, including a shrinking population and slumping industries. However, the establishment of new transport services based on the use of automated driving vehicles—such as circuit buses consisting of automated driving vehicles and on-call automated driving taxis—to provide new means of supporting lives and logistics in regional areas could underpin an infrastructure for local residents' lives. This will improve the quality of the lives of people living in rural areas. If revitalization can be stimulated in this way, vitality will naturally be imparted to these areas and an environment capable of fostering various new industries by harnessing the inherent advantages possessed by regional areas—such as their natural beauty, human resources, and local specialty products—will likely emerge. This will in turn help revive local areas. In this context, automated driving vehicles will probably play a catalytic role in the revitalization of regions.

iv. Japan’s automotive-related industry will continue to maintain its world-leading position by prevailing in the global competition for developing automated driving vehicles

The Japanese automotive industry is an industry that represents Japan by maintaining a world-leading competitive edge. Supported by a vast expanse of supporting industries, the automotive industry drives the Japanese economy as the central element of many related sectors by posting huge sales figures and employing a massive number of workers. Among automotive manufacturers around the world, the primary battle these days is being fought by participants seeking to commercialize their automated driving vehicles as quickly as possible. Furthermore, startups, IT related firms, and other companies which did not have any involvement in automobiles in the past have actively been entering the field of automated driving development in recent years. With each passing year, this competition over the development of technologies is becoming more and more intense. The unassailable positioning of the Japanese automotive industry, startups, and IT related firms as global leaders through the commercialization of automated vehicles ahead of the rest of the world, achieved by prevailing in a competition over the development of automated driving vehicles being fought by the Japanese automotive related industries with overseas automotive manufacturers, is also essential for the future economic growth of the country.

As stated above, automated driving vehicles hold tremendous promise as something that will invoke a "transportation revolution" by providing support for new ways of living and new modes of mobility and logistics for everyone in Japan that will allow us to live affluent lives by solving many societal problems.

C. The vision of society realized through MaaS and other new mobility services

It is expected that MaaS and mobility services utilizing AI and IoT will help solve the various road transport problems faced by Japan. In particular, it is conceivable that they will contribute to solving the poor mobility, which is occurring against the backdrop of noticeable aging of the population and the decline in discontinuation of public transportation services in regional areas, and achieving mobile efficiency with respect to severe traffic jams in urban areas.

Furthermore, in the Initiative/Roadmaps, MaaS (Mobility as a Service) is defined as "a service which presents the user with the optimal route from the place of departure to the destination while also collectively providing multiple means of transportation including other services." Moreover, new mobility services generally refer to new transport services such as car sharing and demand transportation which utilize AI and IOT including MaaS.

i. Poor mobility

New mobility services will contribute to the growing problem of poor mobility as a means to realize a society where all citizens can move about unimpaired regardless of the region. For example, because there are many cases where elderly people in the countryside who are unable to walk face challenges in accessing transportation facilities, there is a possibility that door-to-door demand-based transport services which allow routes and schedules to be flexibly selected and personal mobility which connects public transportation and the home to cover the last mile movement as a moving object may function in an effective manner. Moreover, in cases where it is difficult to secure the transportation which is necessary for the lives of local residents through bus and taxi operators, systems are being established to secure regional transportation by registering under the Road Transportation Act with the agreement of local parties, having local municipalities and NPOs establish transportation safety related measures, and using private vehicles to provide transportation for a fee. The realization of such a society holds the possibility of yielding secondary benefits beyond the framework of mobility such as energizing the movement of those with poor mobility, activating economic activity, and revitalizing the countryside by creating bustling towns such that new mobility services play an important role.

ii. Responding to logistical problems

In addition to the driver shortage problem in logistics services, the demand for shipping is decreasing due to the population decline particularly in depopulated areas, and the ability to sustain logistics services is becoming a serious problem. The spread of services for matching shippers and drivers (logistics P2P matching services) and services that mix people and items will contribute to improving shipping efficiency and can be expected to help the logistics industry by resolving the serious driver shortage and securing shipping to underpopulated regions that are difficult to ship to.

iii. Movement efficiency

Severe traffic jams in urban areas trigger various problems such as economic losses due to the decrease in productivity and environmental problems. The use of new mobility services and personal mobility such as ridesharing which matches passengers heading in the same direction and transporting them together are effective ways to increase road usage and transport efficiency for such situations. In addition, integrating and linking multiple means of transportation through MaaS will restrain the excessive use of automobiles by resolving the inefficiency and inconvenience of segmented transportation for each transportation mode while also contributing to the optimization of the overall traffic flow. In other words, the advancement of ridesharing and other individual mobility services, the

optimization of traffic flow spanning multiple means of movement through MaaS, as well as the optimization of not only the movement of people but also of distribution throughout the region will demonstrate synergistic effects in the future and realize the optimization of the entire region according to needs within the movement of people, items, and all other forms of movement.

iv. Ensuring competitiveness within newly flourishing industrial fields

MaaS and other new mobility services are expected to spread and advance further around the world in the future. In addition, they can be expected to create new services through the fusion of mobility with peripheral non-mobility areas by linking data across industries and also lead to the development of smart cities. As new mobility services become increasingly important as an industrial field, the maintenance of start up support and other business environments will become important to strengthen and ensure the competitiveness of the field's leaders. Moreover, if automated driving technologies develop and merge with mobility services, it will have a tremendous impact on the state of the automobile industry, which is a core industry of Japan. Therefore, unified public and private sector initiatives with respect to this field are also extremely important from the perspective of continuous economic development in the future.

D. The vision of society realized through automated driving and MaaS

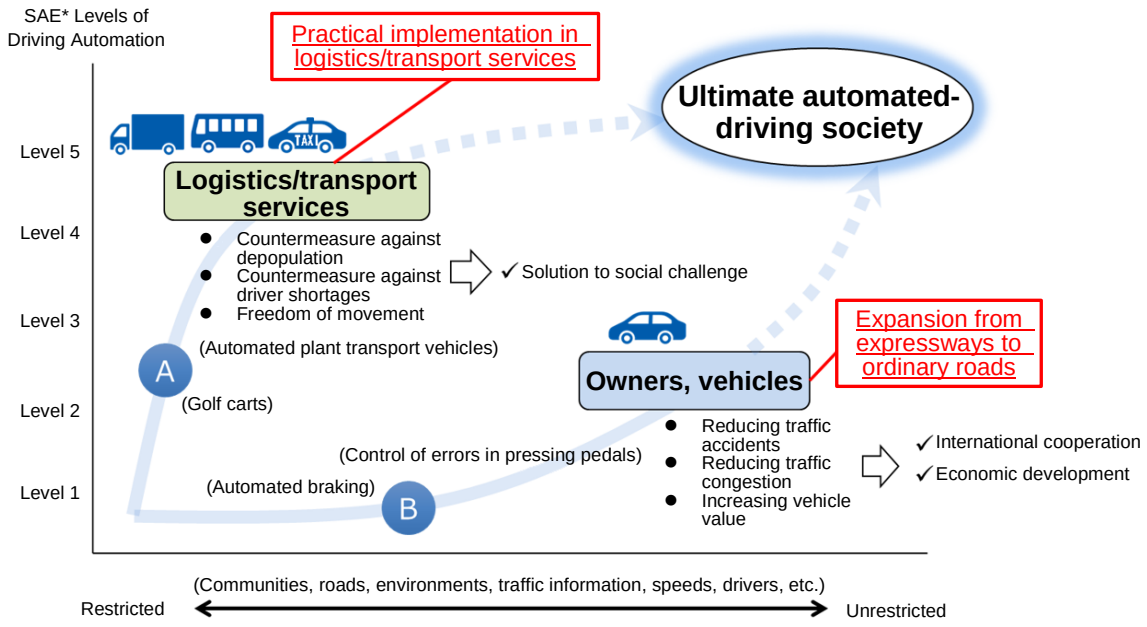
If automated driving becomes integrated into society in the future, the state of mobility will significantly transform. Specifically, providing the movement of people and items as a service through automated driving will make it possible for anyone to freely move about in a manner that is safe, convenient, and inexpensive. At the same time, it can be expected to create the ultimate mobility society in which traffic flows are optimized throughout the entire region in relation to all forms of movement including people and items under the MaaS service system. At that time, the barriers among mobility such as car sharing, taxis, buses, trucks, private vehicles and other automobiles will become fuzzy, which is likely to have a significant impact on the industrial structure of the transportation industry.

However, when the lead time required for the maturity of automated driving technologies and the cultivation of social acceptance are taken into account, it should be noted that the arrival of that final vision of society will occur in the distant future. In particular, because private vehicles can be used for many different applications and there are no geographic restrictions on their range of movement, it is expected that the implementation of completely automated driving will require a considerable amount of time. In contrast, there is a strong possibility that automated driving will be implemented in buses and service vehicles used for distribution etc. before private vehicles, because their

applications and range of use are limited. Therefore, in order to rapidly advance the implementation of automated driving and MaaS in Japanese society, it is important to steadily introduce and implement new mobility services and MaaS which are not necessarily predicated on the introduction of automated driving while steadily advancing the implementation of automated driving in the service vehicle field according to the maturity of the technologies and the cultivation of social acceptance. Moreover, it is believed that creating the automated driving and MaaS infrastructure in the service vehicle field and promoting the verification of issues in advance will directly link to the forthcoming full-scale merging of automated driving and MaaS, which includes the field of private vehicles.

At the same time, it is important to improve the safety of private vehicles through the early application and spread of advanced driving safety support systems which use automated driving technologies to solve urgent issues such as preventing traffic accidents involving elderly drivers instead of waiting for the arrival of the full-scale automated driving society. Taking both of these approaches can be expected to lead to the maintenance and improvement of the competitiveness of Japanese industries over the long-term.

Figure 1: Scenario for achieving the ultimate automated driving society[2]



* SAE (Society of Automotive Engineers): a standardization organization in the United States

2 The second phase of SIP-adus

2 Automated driving

(1) Definitions of Automated Driving Systems

<Definitions of levels of driving automation >

Ranging from driving performed entirely by the driver and driving partially performed by the vehicle's driver assistance system to driving performed entirely without the driver's involvement, there are various concepts of driving in terms of the driver's level of involvement in driving.

The definitions provided by SAE International's J3016[3] (September 2016) and the JASO TP 18004[4] (February 2018) Japanese reference translation are utilized as definitions of levels of driving automation in the Initiative/Roadmaps. Accordingly, particulars can be accessed by referring to these definitions. An outline of these definitions is provided in Table 1.

In addition, automated driving systems at Level 3 and above are called "Highly Automated Driving Systems"[5], and those at Levels 4 and 5 are called "Fully Automated Driving Systems" in the Initiative/Roadmaps.

Table 1: Overview of the definitions of levels of driving automation

Level	Overview	In charge of steering*
Driver performs part or all of the dynamic driving tasks.		
Level 0 No Driving Automation	• The driver performs all dynamic driving tasks.	Driver
Level 1 Driver Assistance	• A system performs vehicle motion control sub-tasks in either a longitudinal or a lateral direction within an operational design domain.	Driver
Level 2 Partial Driving Automation	• A system performs vehicle motion control sub-tasks in both longitudinal and lateral directions within an operational design domain.	Driver
Automated Driving System performs the entire dynamic driving tasks (while engaged)		
Level 3	• A system performs the entire dynamic driving tasks	System

3 SAE International J3016 (2016) "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicle".

4 JASO technical paper "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles" (published on February 1, 2018)

5 In the Federal Automated Vehicle Policy (September 2016) by the U.S. NHTSA, vehicles of SAE Level 3 and above are called "highly automated vehicles (HAV)."
Furthermore, "Automated Driving System: ADS" in J3016 refers to systems which are Level 3 and above. Likewise, while the ASV Promotion Advisory Council refers to Levels 1 and 2 as "driver assistance," because the name for Level 3 and above is still under discussion, the Initiative/Roadmaps uses "automated driving system" as a general term for systems involved in driving automation as in the past for the sake of convenience. However, the name used for automated driving will be revised in 2020 based on the status of future discussions within the ASV Promotion Advisory Council and other organizations.

Conditional Driving Automation	within an operational design domain. • Dynamic driving tasks fallback-ready user is receptive to system issued requests to intervene and will respond appropriately.	(Dynamic driving tasks fallback-ready user)
Level 4 High Driving Automation	• A system performs the entire dynamic driving tasks and dynamic driving tasks fallback within an operational design domain.	System
Level 5 Full Driving Automation	• A system performs the entire dynamic driving tasks and dynamic driving tasks fallback unconditionally (in other words, not within an operational design domain).	System

※ Performing actions of recognition, prediction, judgment, and operation

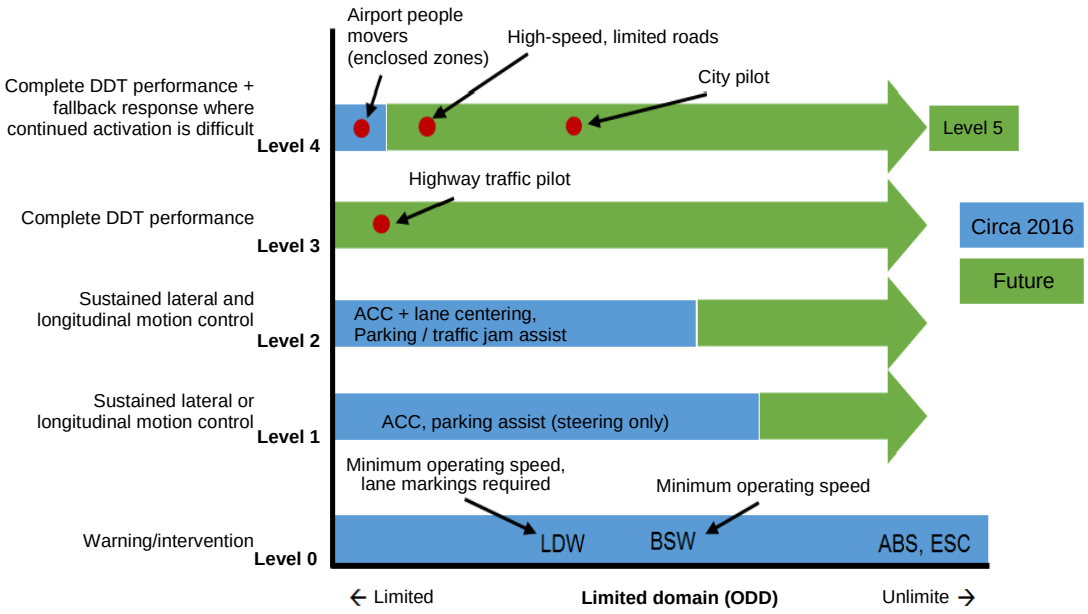
The definitions of the terms in J3016 are shown below.

Term	Definition
Dynamic Driving Task (DDT)	• All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions as such as trip scheduling and selection of determinations and waypoints. • Including, but not limited to, the following sub-tasks: 1) Lateral vehicle motion control via steering (operational); 2) Longitudinal vehicle motion control via acceleration and deceleration (operational); 3) Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical); 4) Object and event response execution (operational and tactical); 5) Maneuver planning (tactical); 6) Enhancing conspicuity via lighting, signaling and gesturing, etc. (tactical)
Object and Event Detection and Response (OEDR)	• The subtasks of the DDT that include monitoring the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e., as needed to complete the DDT and/or DDT fallback).
Operational Design Domain (ODD)	• Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.

In the J3016, the range of "operational design domains (ODD)" serves as an important benchmark for evaluating automated driving technologies as well as levels of driving automation. That is to say, at any of the Levels 1 through 4, the wider the ODDs that are specific conditions under which the automated driving system is designed to function are, the more technically sophisticated the system is. In other words, even at Level 4, if the system enables automated driving within a narrow range of ODDs, its level of technical sophistication is relatively low.

In addition, Level 5 is defined as one of the Level 4 automated driving systems but with unlimited ODDs, and thus its technical level is very high.

Figure 2: Significance of ODD at each level of driving automation



These definitions will be reviewed as needed in accordance with SAE's review of their definitions.

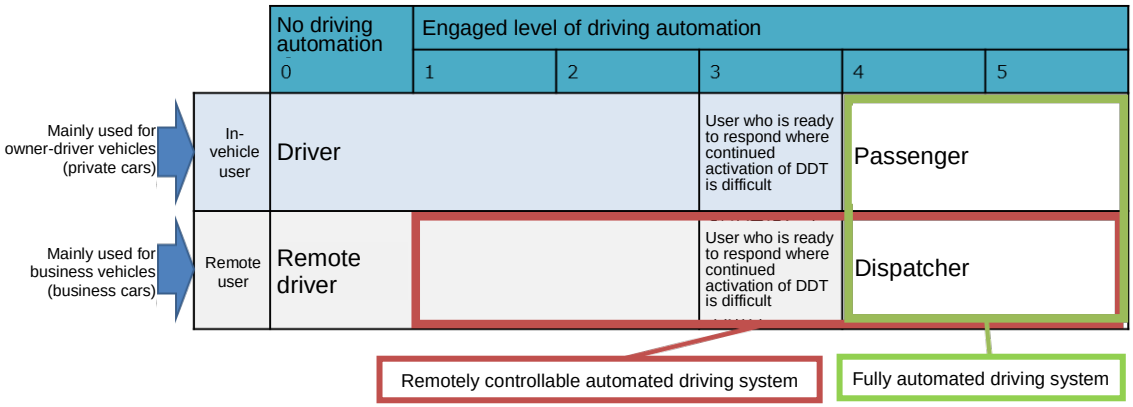
<Definition of a remotely controllable automated driving system>

According to J3016, automated driving systems are divided into those with a user who is inside the vehicle (including those who are the equivalent of drivers; hereinafter the same applies) and those with a user outside the vehicle who remotely monitors and operates it.

Within this definition, the Initiative/Roadmaps define the latter "driving automation system with the user outside the vehicle"[6] as a "remotely controllable automated driving system," and transport services that use automated driving systems without a driver inside the vehicle, including remotely controllable automated driving systems, are called "driverless automated driving transport services."

6 In this case, the user plays the following roles according to levels of driving automation.
At SAE Level 2, "Remote Driver" remotely performs monitoring and operation.
At SAE Level 3, "DDT Fallback-Ready User" positioned remotely performs monitoring and operation in case of a request to intervene made by the system.
At SAE Level 4, "Dispatcher" (tentative translation, formal translation will be discussed) positioned remotely operates the vehicle in case of necessity such as vehicle malfunction.

Figure 3: User roles during the operation of automated driving systems



<Definitions of specific automated driving systems>

Based on the above-mentioned definitions of J3016, the Initiative/Roadmaps 2018 describes "semi-autopilot" and "autopilot" as specific automated driving systems that are expected to be commercialized and applied to services in the near future and defines them as follows.

Table 2: Specific Automated Driving Systems and Overview

Name of System	Overview	Corresponding Level
Semi-Autopilot	• It supports automated driving on expressways (from entrance ramps to exit ramps; merging, lane change, lane keeping or adaptive cruise control, diverging, etc.). • Though the driver performs object and event detection and response for safe driving during automated driving mode, the system notifies the driver of traveling conditions.	Level 2
Autopilot	• It supports automated driving on expressways and under other specific conditions. • Though the system performs all the DDT during automated driving mode, the driver takes over in response to a request by the system.	Level 3

(2) Strategies pertaining to automated driving

A. Social Impact of Automated Driving

While automated driving systems are not expected to readily become common, they are expected to spread rapidly over the coming ten to twenty years and have a significant impact on society.

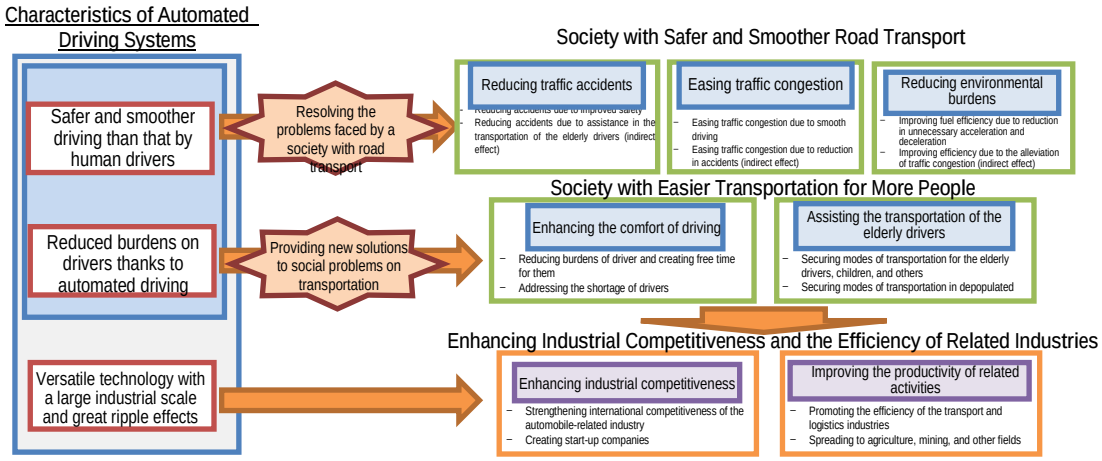
Specifically, driving via automated driving systems is generally safer and more efficient than that by humans; therefore, these systems can significantly contribute to solving issues faced by a

society with conventional road transport, such as reducing traffic accidents, alleviating traffic congestion, and reducing the environmental load.

Moreover, in addition to solving those issues, automated driving systems can drastically reduce the burden of driving on drivers. In particular, sophisticated automated driving systems potentially provide new means to solve conventional social issues related to mobility.

The automotive industries, including peripheral industries, are large in size and based on highly versatile technologies that have significant ripple effects. Therefore, promoting innovation based on new automated driving technology that can solve the aforementioned issues will not only lead to the strengthening of the competitiveness of the automobile industry and the creation of new industries, but also have a significant impact on various industries through improved efficiency and innovation in the traffic/logistics industry and promote the application of automated driving technology to other fields related to automated driving technology (e.g., agriculture and mining).

Figure 4: Social Expectations for Automated Driving Systems (Example)



B. Social and industrial objectives

With an eye toward the coming ten to twenty years, significant innovation centering on automated driving systems is expected to occur in ITS as mentioned above. In light of this, we will aim to build the following two societies from both the industrial and social perspectives and engage in efforts to achieve these goals.

- Social perspective: Japan aims to build "a society with the world's safest road transport" by 2020 and then aims to build and maintain "a society with the world's safest and

smoothest road transport”[7] by 2030 by promoting the development and popularization of automate driving systems and the preparation of data platforms.

- Industrial perspective: Japan aims to expand the export of ITS-related vehicles and infrastructure via public-private collaboration and become a global hub of innovation related to automated driving systems (including the development of data platforms) after 2020.

In an effort to set the vectors of the public and private sectors in the same direction toward the realization of such a society and industries and keep track of progress in such efforts, toward 2020, we will set key indicators for the achievement of objectives, mainly a reduction in traffic accidents, based on the Fundamental Traffic Safety Program and promote necessary measures based on the set indicators.[8]

For the key objective achievement indicators toward 2030, while keeping the widespread use of automated driving systems in mind, social indicators related to “reduction in traffic accidents,”[9] “alleviation of traffic congestion,”[10] “streamlining of logistic traffic,”[11] and “transportation support for the elderly drivers,”[12] and industrial indicators related to “popularization of automate driving systems,” “production and export of vehicles,”[13] and “export of infrastructure” shall be set.[14] When setting specific numerical targets, numerical targets of other countries shall be referred to as benchmarks since Japan aims to realize and maintain the safest road traffic in the world. The set numerical targets shall then be compared with those of other countries in an ongoing manner, and revised on an as-needed basis.

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7 “The world's smoothest" here indicates a traffic situation with little congestion, which enables the elderly drivers to move smoothly without any stress. Moreover, the realization of smooth road transport by alleviating traffic congestion is expected to contribute to reducing effects on the environment.

8 When examining the measures, the first phase of SIP-adus shall implement a survey on the methods to estimate the effects in reducing traffic accidents related to automated driving systems and examine the measures based on the results of the survey.

9 When examining traffic accident-related indicators, a reduction in the number of persons injured from traffic accidents should be included as an indicator, as well as indicators related to the number of fatalities from traffic accidents (such as aiming to achieve zero deaths from traffic accidents, etc.)

10 The Declaration of Creation specifies that indicators related to traffic congestion be set as KPIs. In the future, the existing data on traffic congestion, including surveys on the methods used overseas to obtain congestion data, shall be sorted out, and methods to obtain such data using probe data shall be studied and considered to set specific indicators.

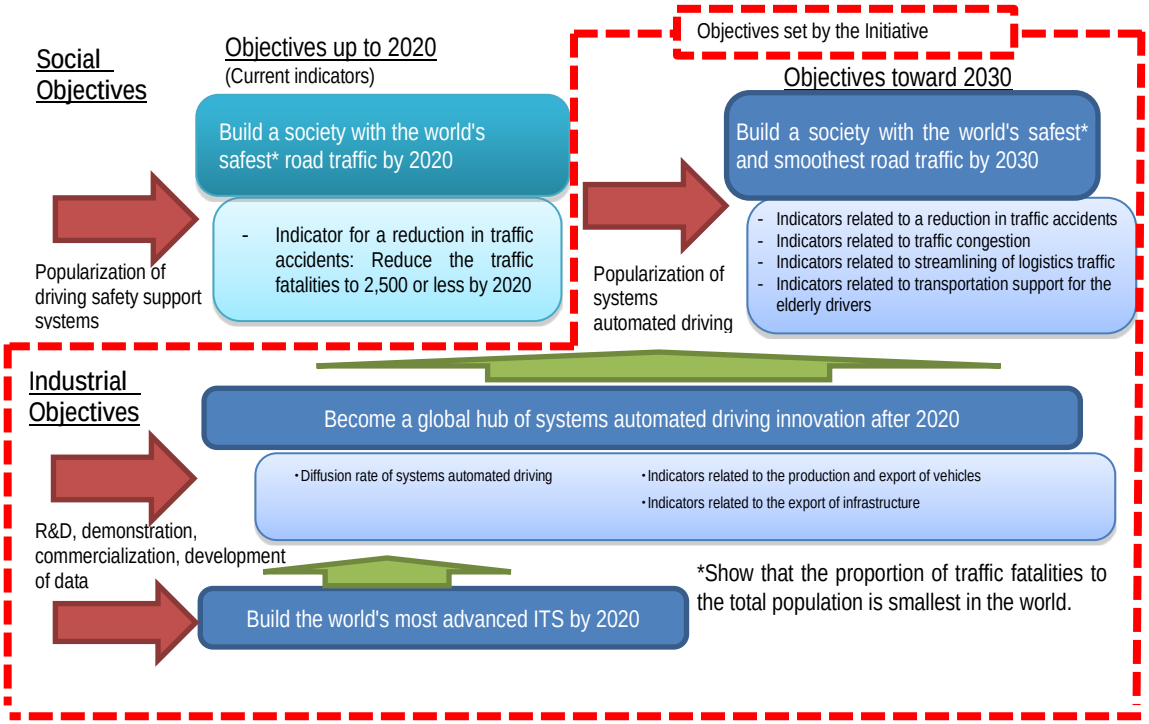
11 Indicators related to the streamlining of logistics traffic require further consideration.

12 For indicators related to the mobility of the elderly drivers, specific indicators and methods to measure them, such as the rates of utilization of public transportation and automobiles by the elderly drivers, shall be examined in the future.

13 As for indicators related to the production and export of vehicles, they will be measured based on the number of vehicles for the time being. In the future, however, due consideration should be given to the possibility that the surrounding business, such as car sharing, may become more important.

14 When setting specific indicators and numerical targets, discussions shall be held on statistical data required to determine them with industry, and examinations shall be conducted in consideration of surveys on the assessment of the impact of automated driving systems on society.

Figure 5: Society that the Initiative aims for and Key Indicators for the Achievement of Objectives



C. Basic strategies

Basic strategies for and social impact by automated driving systems

For automated driving systems, we will build the world's most advanced ITS by 2020 by commercializing semi-autopilot and autopilot and realizing driverless automated driving transport services by 2020. Then, with an eye toward further sophistication of the systems, including technology that achieves fully automated driving systems, and the deployment of such systems in the world, we will aim to reduce traffic accidents, alleviate traffic congestion, support the mobility of the elderly drivers by introducing automated driving systems mainly for new vehicles into society and spreading them across the country, and build a society with the world's safest and smoothest road transport by 2030.

In Japan, while traffic accidents by the elderly drivers account for most of the total in the aging society, transportation means for people with poor mobility such as the elderly drivers need to be secured. It is also urgent to secure transportation means in underpopulated areas and address the lack of drivers, since Japan's population is projected to decline. By working on the development of highly automated driving systems, which are considered important in solving these urgent issues in a strategic manner with business models in mind, Japan aims to realize automated driving systems

ahead of the world and strengthen its global industrial competitiveness.[15] Specifically, highly automated driving systems with the following 3 items as objectives should be prioritized, and efforts should be made for their commercialization and popularization by 2025.

i. Further sophistication of automated driving systems for private vehicles

ii. Realization of innovative, efficient logistics services to address the lack of drivers

iii. Realization of driverless automated driving transport services for rural areas and the elderly

Table 3: Society and automated driving systems to be achieved

Item	Society to be achieved (example)	Automated driving to be achieved
Sophistication of automated driving systems for private vehicles	Strengthening of industrial competitiveness Reduction of traffic accidents Alleviation of traffic congestion	• Fully automated driving on expressways (Level 4) • sophisticated driving safety support systems (tentative name)[16]
Realization of innovative, efficient logistics services to address the lack of drivers	Innovative streamlining of logistics responding to the era of population decrease	• Truck platooning on expressways (Level 2 and above) • Fully automated trucks on expressways (Level 4)
Realization of driverless automated driving transport services for rural areas and the elderly	Society that enables the elderly drivers to freely move around the country	• Spread of driverless automated driving transport services in specified areas across Japan

<Basic strategies for driving safety support systems>

For driving safety support systems, while we should keep casting a careful eye toward 2020 and onward when automated driving systems are expected to be widely used, we shall, up to 2020, work toward the realization of a society with the world's safest road transport (traffic fatalities of 2,500) and the world's most advanced ITS.[17]

Specifically, while promoting automobiles equipped with driving safety support functions such as Advanced Emergency Braking Systems (AEBS) that have become popular in recent years, in light

15 Though automated driving is a promising technology that may solve various issues that Japan faces, it is not the only method for solving them. It is socially expected to solve such issues based on overall optimization by combining automated driving with various methods.

16 The official name for the sophisticated driving safety support systems (tentative name) will be discussed. It should be noted that it is not a sophisticated version of the Driving Safety Support Systems (DSSS) whose practical application has already been promoted (see B for details.)

17 Especially when promoting measures to reduce traffic accidents, it is necessary to identify measures to focus on by taking into account the results of the analysis of the current situations of traffic accident fatalities (analysis of accident situations such as locations of intersections, collisions, pedestrians, etc.) and examining the possibility of the spread (expected amount of measures widely implemented as of 2020 etc.) of technical measures to deal with such situations including their feasibility and cost effectiveness.

of the fact that it will take time to popularize new vehicles equipped with such devices[18], the introduction and popularization of driving safety support devices to be installed on existing vehicles and the introduction of information systems required to provide information that will be useful in the reduction of traffic accidents and alleviation of traffic congestion shall also be promoted.

Approaches to the realization of automated driving systems

As a basic approach (policy) toward the implementation of automated driving systems in society, Japan aims to be the world's best both in "technology," one of the tangibles of automated driving, and "commercialization," one of its intangibles. From such a standpoint, we aim to implement automated driving systems in society by utilizing the latest technologies and complementing them with institutions and infrastructures, rather than implementing them only after technologies are completely established. Since it is important that vehicle performance surpass the complexity of the driving environments, we will consider categorizing and indexing the complexity of driving environments and tangible and intangible performance of the vehicle and, based on their combinations, select areas and promote the examination of required performances. Taking the results of this benchmarking into consideration, we will expand the Operational Design Domains (ODDs), i.e., the specific conditions under which automated driving systems are designed to function, so that they include complex driving environments.

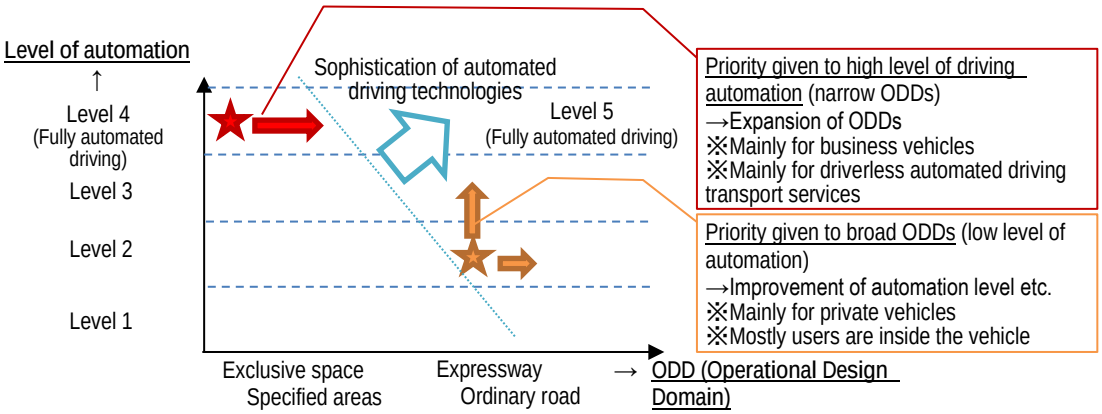
For the evolution of automated driving technology, there are roughly two approaches to the realization of technology that enables fully automated driving in a wide variety of traffic conditions.

i The approach that gradually increases levels of driving automation with priority given to addressing broad ODDs (e.g. Various traffic situations such as the entire expressway): This approach will be the strategy mainly for automated driving systems for private vehicles (including commercial vehicles) that are generally required to drive regardless of location and time. In many cases, private vehicles with such automated driving systems have drivers inside.

ii The approach that starts working from narrow ODDs (narrowly limited traffic situations) and then gradually expand those ODDs gradually with priority given to realizing a high level of driving automation: This approach will be the strategy mainly for automated driving systems used for business vehicles (local public transportation, freight transportation, etc.) that can be serviced at limited locations within a limited time.

18 The number of automobiles owned in Japan in recent years is about 80 million. The annual number of new automobiles sold is about 5 million. Therefore, it will take about more than 15 years to completely replace existing automobiles with new ones.

Figure 6: Two approaches to the realization of automated driving systems



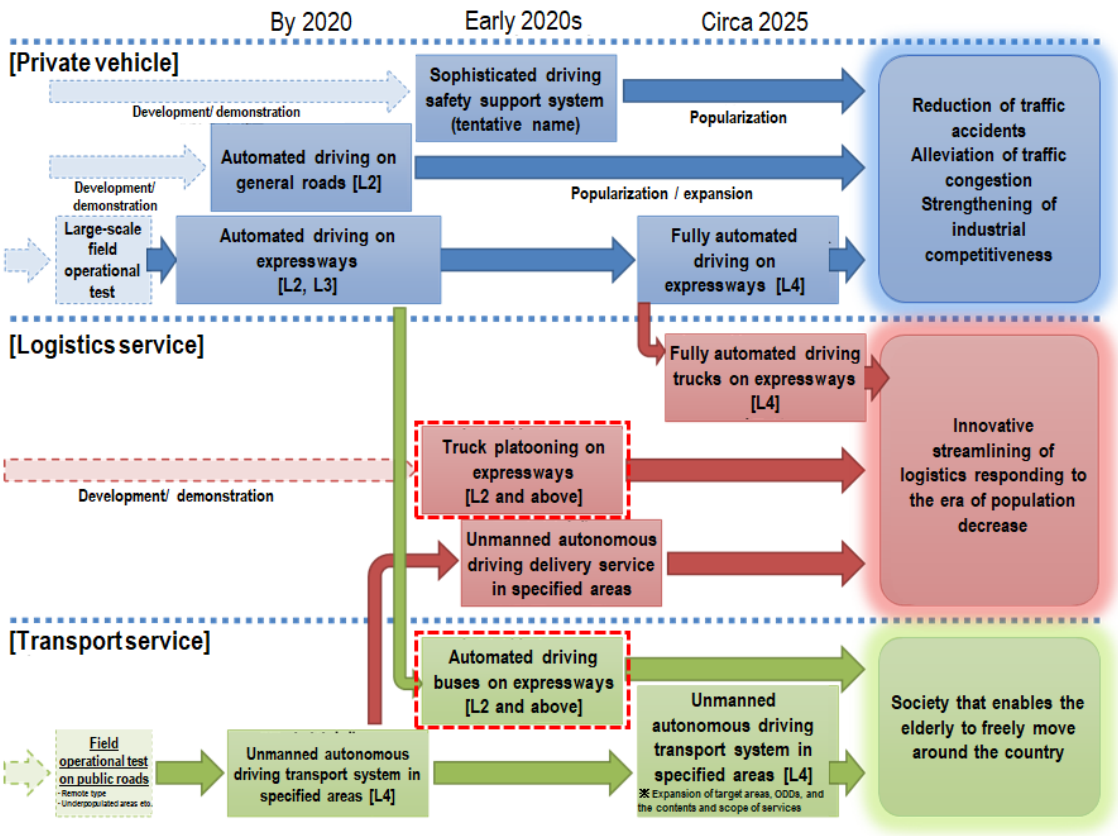
Taking these approaches into consideration, the Initiative / Roadmaps specifies the strategies for the commercialization of automated driving systems utilized for private vehicles, those utilized for business vehicles such as transportations services, and those utilized for logistics vehicles (trucks etc.) as applied to the logistics area in light of the social objectives described above.[19]

Specifically, we will make efforts to realize the (1) commercialization of vehicles that can be automatically driven on expressways (semi-autopilot and autopilot) and (2) provision of driverless automated driving transport services in specified areas (underpopulated areas, etc.[20]) by 2020. Then, we aim to realize the commercialization of fully automated driving systems on expressways, the introduction and popularization of automated driving systems in the logistics area, and the popularization of driverless automated driving transport services for specified areas throughout Japan by 2025.

19 Though the Initiative/Roadmaps 2019 discusses automated driving systems for private vehicles, logistics services, and transport services separately, their concepts and names will be further reviewed in light of the future direction of automated driving systems and services utilizing them.

20 From the policy perspective of securing transportation means in rural areas, driverless automated driving transport services should be realized first in underpopulated areas. However, from a business perspective, their introduction in urban areas and suburban areas may be considered.

Figure 7: Scenario for the realization of commercialization and service of fully automated driving by 2025



(Note) Based on the above schedule, the relevant ministries and agencies will cooperate with the private sector and promote the necessary measures according to the specific status of their development and business models. In doing so, they will promote information sharing between the government and the private sector, provide advice, and review systems and infrastructure as needed.

<Scenarios and the expected timing of commercialization and service implementation of automated driving systems>

Based on the objective of becoming the world's best, we have set the expected timing of the commercialization[21] of automated driving systems at each level (timing comparable to those of other countries, that is, the fastest or almost the fastest in the world) while referring to the commercialization objectives and roadmaps of other countries. However, in light of the recent progress in technological development by private companies, we have specified the expected timings for the commercialization and service of automated driving systems for private vehicles and business vehicles (logistics services and transport services) separately as shown below.

21 The expected timing of commercialization is the common target timing by which the government and private sector must address various measures. It is not the timing for them to express their commitment.

For these systems, it is important to aim to become the world's number one in terms of not only the expected commercialization timing, but also the enhancement of industrial competitiveness and the popularization of automated driving systems.

In addition, microcars and bus platooning on expressways are some of the technologies that are also expected to be realized in the future.

Table 4: Expected timing of commercialization and service of automated driving systems *1

		Level	Technology expected to be realized (example)	Expected timing of commercialization etc.
Sophistication of automated driving technologies				
	Private vehicle	Level 2	Semi-autopilot	By 2020
		Level 3	Autopilot	Circa 2020※3
		Level 4	Fully automated driving on expressways	Circa 2025※3
	Logistics service	Level 2 and above	Driver-assistive truck platooning on expressways	By 2021
			Truck platooning with the trailing truck unmanned on expressways	From 2022
		Level 4	Fully automated driving of trucks on expressways	From 2025※3
	Transport service	Level 4※2	Driverless automated driving transport services in specified areas	By 2020
		Level 2 and above	Automated driving of buses on expressways	From 2022
Sophistication of driver assistance technologies				
	Private vehicle		Sophisticated driving safety support systems (tentative name)	(Early 2020s) It may vary depending on future discussions

(※1) At the expected timing of commercialization, technologies of remotely controllable automated driving systems and automated driving systems of Level 4 and above must be consistent with Convention on Road Traffic. In addition, the expected timing of commercialization shall be reviewed based on the domestic and overseas industrial and technology trends, including overseas trends in the development of automated driving systems.

(※2) Though driverless automated driving transport services range from Level 0 to 5 by definition, it is expected that the driverless automated driving transport service of Level 4 will be realized by 2020.

(※3) The timing is set as a target time by which the government should make efforts to enable commercialization by private companies.

(3) Initiatives for commercialization

A. Initiatives to improve the environment (Charter for Improvement of Legal System and Environment for Automated Driving Systems)

In order to enable the actual operation of highly automated driving systems, a full review of the existing traffic-related laws and regulations is required. The scope of consideration for the review

ranges from identification of automated driving vehicles and systems and the roles of safety regulations, traffic rules, and so on to clarification of responsibilities such as automobile liability insurances. In addition, since they are considered to be mutually related, it is necessary to clarify the policy of the whole government on improvement of legal system toward the realization of highly automated driving systems. Therefore, the Charter for Improvement of Legal System and Environment for Automated Driving Systems, a policy on improvement of legal system by the entire government towards the realization of highly automated driving systems, was formulated in close collaboration with related ministries and agencies and finalized by the IT Strategic Headquarters (April 17, 2018).

Though such improvement of legal system is a matter of global concern, other countries are still in the trial and error stage, and international discussions involving Convention on Road Traffic are being undertaken. In addition, given that there are no established technologies pertaining to automated driving, various technologies are expected to emerge in the future, and time will be required to develop international technical standards. Thus, it was decided that we need to hold a follow-up meeting every half year on matters concerning legal systems and promote ongoing studies concerning the revision of legal systems.

Since that time, a total of two follow-up meetings have been held to date, and the studies concerning the legal system revision continue to advance. The following describes the current status based on the Charter for Improvement of Legal System and Environment for Automated Driving Systems and the follow-up meetings.

<Basic concepts>

Japan shall consider the policy (outline) on improvement of legal system toward the realization of highly automated driving systems based on the following basic approach (strategy):

- Exercise international leadership in institutional approach from a mid-term perspective
- Develop an institutional framework that promotes innovation while securing safety
- Clarify responsibilities in a way that promotes innovation while giving priority to social acceptance

Based on the above thinking, institutional investigations will be conducted in accordance with the following basic policy in light of the fact that the current environment surrounding automated driving is such that we are at the outset in terms of the innovations that will give birth to the various technologies of the future and of the process by which these technologies will become popularized, and in light of the fact that, despite the relative lack of safety evaluations and institutional precedence internationally, ensuring safety is an important objective, such that future technological progress and international trends will need to be taken into account.

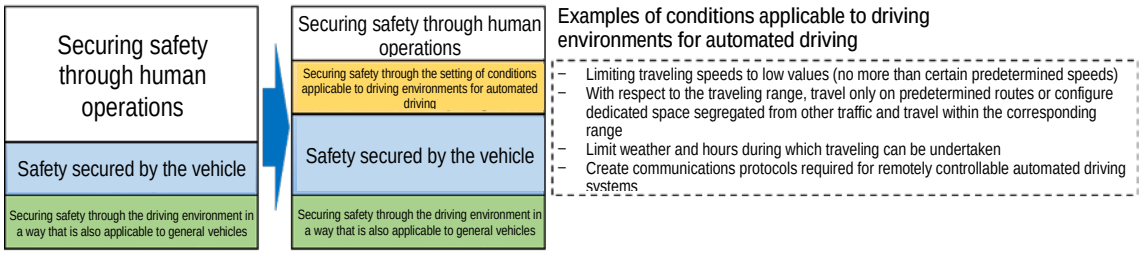
- The inventiveness of businesses in response to social acceptance and social needs should be promoted;
- Earlier detection of and response to safety issues while giving priority to the need to ensure safety shall be promoted;
- Environmental changes affecting automated driving should be flexibly accommodated, such as by gradually reviewing institutions and systems.

<Ensuring safety on an integrated basis>

In order to ensure safety, there has conventionally been a need to reach a certain level at the intersection of three different elements: people, vehicles, and driving environments.

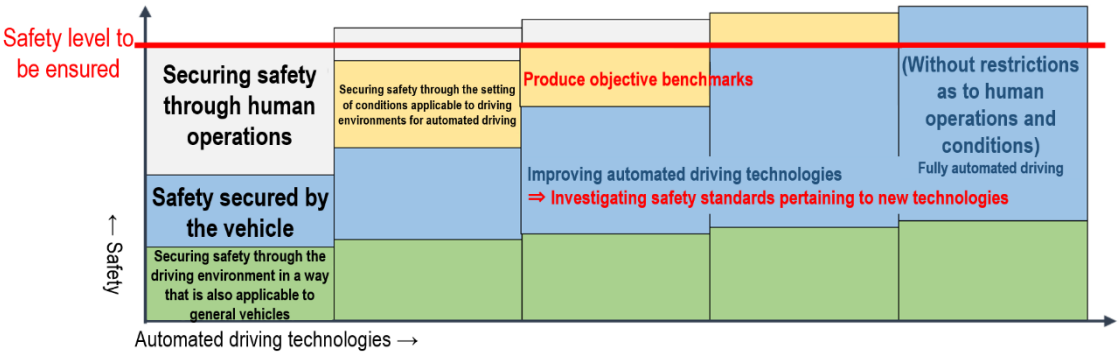
As automated driving technologies evolve, greater safety is secured as human operations are displaced in part by the vehicle itself. Safety will be difficult for the vehicle alone to ensure in a complex traffic environment during the initial rollout of automated driving systems; however, new conditions applicable to driving environments for automated driving will be set to ensure safety in combination with the role played by the vehicle in ensuring safety.

Figure 8: Thinking on ensuring safety through the setting of conditions applicable to driving environments for automated driving



In line with the evolution of automated driving technologies, we expect to see greater levels of safety reached in the future.

Figure 9: Illustration of the way in which steps will be progressively taken towards the commercialization of automated driving



In line with these notions, we will investigate safety regulations according to technical levels and investigate and formulate conditions applicable to driving environments for automated driving as objective benchmarks in collaboration with concerned ministries and agencies.

For the time being, however, we will establish a scheme for ensuring safety by verifying conditions on a case-by-case basis in collaboration with concerned ministries and agencies after taking into account regional idiosyncrasies rather than applying universal conditions, as well as for ensuring safety in an integrated manner by setting safety regulations and conditions applicable to driving environments for automated driving (operating and driving environments).

- Progress and status as of the end of March 2019

  - Regarding the response for the time being, we will investigate the required scheme based on "Automated Driving Service Conducted at the Roadside Station - Michi no Eki, as a Base" and "Improving the Environment Toward Practical Application of Transport Services Based on Automated Driving in Regional Areas" from Ministry of Land, Infrastructure, Transport and Tourism (MLIT)/Cabinet Office SIP, "Last-mile Automated Driving" from Ministry of Economy, Trade and Industry (METI) and MLIT, and other field operational testing cases, traffic rules, and various research results concerning vehicle safety measures and driving environments, etc. Moreover, regarding the methods to verify and monitor whether vehicles are operated within the scope of the conditions applicable to driving environment for automated driving, we will investigate the required methods based on various research results concerning vehicle safety measures and traffic rules, etc.
  - Regarding the investigation of the objective benchmarks, we shall examine the required benchmarks based on "Automated Driving Service Conducted at the Roadside Station - Michi no Eki, as a Base" and "Improving the Environment Toward Practical Application of Transport Services Based on Automated Driving in Regional Areas" from MLIT/Cabinet Office SIP, "Last-mile Automated Driving" from METI and MLIT, and other field

operational testing cases, traffic rules, and various research results concerning vehicle safety measures and driving environments, etc.

<Notions on securing the safety of automated driving vehicles> (Road Transport Vehicle Act and others)

In formulating safety regulations, we will continue to lead international discussions in order to help spread Japanese world-leading automotive technologies around the world.

i. We will summarize the safety requirements to be met by automated driving vehicles into guidelines by around summer 2018;
ii. We will progressively formulate safety regulations applicable to automated driving vehicles based on trends in technological development and international discussions;
iii. We will investigate the ideal approach to be taken in formulating measures to ensure the safety of vehicles in current use;
iv. We will investigate requirements pertaining to vehicles to be driven in a convoy/platoon formation.

- Progress and status as of the end of March 2019

  - Regarding the safety requirements and safety assurance measures which should be fulfilled by automated driving vehicles, the "Guideline regarding Safety Technology for Automated Driving Vehicles" were drawn up and announced in September 2018.
  - Regarding the evaluation methods for verifying whether the required level of safety is being fulfilled by automated driving vehicles, we are serving as the head of the expert meeting committee at the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29), which is discussing certification methods for automated driving vehicles, to take the lead in investigating specific ways of verifying safety performance.
  - In regard to the formulation of international regulations for safety regulations, we are continuing to lead the discussion by serving as the head of subcommittees which are engaged in the relevant discussions. In January 2019, a proposal was drafted for an international regulations on Advanced Emergency Braking Systems (AEBS), and the goal is to have the regulations adopted within 2019. To continue, we aim to draft a proposal for international regulations on cyber security during the first half of 2019 at the earliest and lane keeping systems on expressways (Level 3) during FY2019 at the earliest.
  - Regarding the phased drafting of safety regulations, the "Bill to Revise Part of the Road Transport Vehicle Act", which adds automated driving devices to the equipment covered under the safety regulations, was submitted to the 198th ordinary session of the Diet (*approved on May 17, 2019) based on the conclusion that the "automated driving vehicles

do not pose a danger to passengers, pedestrians, and other peripheral traffic participants" regulations for automated driving systems should be drafted in order to assure the safety of automated driving vehicles in the "report of Sub-committee for Development of System for Advanced Technology for Automated Driving" announced in January 2019.

- Based on the following conclusions of the "report of Sub-committee for Development of System for Advanced Technology for Automated Driving" announced in January 2019 regarding the state of maintenance management (inspection maintenance and automobile inspection verification items) within the measures to assure the safety of vehicles in current use,
  - The maintenance and modification of automated driving systems and other electronic equipment shall be newly covered under "disassembly maintenance" and designated as "specific maintenance" (tentative name), and companies which perform such work should be certified
  - The system and environment should be improved so that the technical information which is required for the inspection and maintenance of advanced technologies is provided to maintenance companies
  - The technical information which is required for inspection should be centrally managed, and a system should be constructed which provides such information to parties who are carrying out the inspections

  the "Bill to Revise Part of the Road Transport Vehicle Act," which expands the scope of disassembly maintenance and mandates the provision of technical information which is required for inspection maintenance, was submitted to the 198th ordinary session of the Diet (*approved on May 17, 2019).

- Based on the conclusions of the "report of Sub-committee for Development of System for Advanced Technology for Automated Driving" announced in January 2019 that the nation should establish a system for verifying the appropriateness of software delivery which has a significant impact on the safety of automobiles regarding the state of assessments of continuous software updates within the measures to assure the safety of vehicles in current use, the "Bill to Revise Part of the Road Transport Vehicle Act," which establishes a permit system concerning the modification of program alterations embedded in automated driving devices, was submitted to the 198th ordinary session of the Diet (*approved on May 17, 2019).
- Regarding the examination of the guidelines for technical requirements that vehicles should fulfill when platooning with so-called "electronic towing (tentative name)", the Advanced Safety Vehicle (ASV) Promotion Advisory Council is examining the guidelines, etc. with

regard to the technical requirements that vehicles should fulfill when platooning based on the trends in field operational testing of platooning.

- Regarding the examination of the guidelines for technical requirements that vehicles should fulfill when platooning by having an independently driving vehicle use vehicle-to-vehicle communication to follow another vehicle, as part of the phased safety regulations formulation, we are continuing to proceed with our examination based on technical trends and international discussions while being careful not to impede technology diversity.

- Regarding certification system of relaxing a part of the safety regulations which can be applied in current field operational testing, the conclusions of the "report of Sub-committee for Development of System for Advanced Technology for Automated Driving" announced in January 2019 were to expand the scope of application to add driverless automated driving transport service vehicles, based on the premise that safety assurance measures were guaranteed, and that the certifications system should be made applicable during commercialization as well.

<Traffic rules> (Road Traffic Act and others)

With a focus on commercialization in 2020, we will continue to spearhead cooperation with concerned countries in the course of engaging in international discussions at the Convention on Road Traffic (Geneva Convention), and we will investigate traffic rules aimed at commercializing world-leading technologies premised on ensuring safety in accordance with progress in this area and with progress in terms of the development of technologies.

i. We shall pursue investigations on domestic statutory revisions in line with international discussions and quickly develop a domestic legal system in accordance with international discussions and progress in terms of the development of technologies relating to automated driving.
ii. We shall study measures required to ensure that automated driving systems comply with norms set forth in road traffic laws and regulations.
iii. We will examine the policy regarding the case in which trucks engage in platooning using so-called "electronic towing (tentative name)" based on current towing.
iv. With respect to driverless automated driving transport services in specified areas, the current framework for field operational testing used for remotely controllable automated driving systems will also be rendered usable for commercialization for the time being.

- Progress and status as of the end of March 2019
  - We are actively participating in international discussions as a member of UNECE Global Forum for Road Traffic Safety (WP.1) and the unofficial group of experts on automated

driving set up in the WP.1. During international discussions in recent years, we discussed the "Road Traffic Safety Global Forum (WP.1) Resolution on the deployment of highly and fully automated vehicles in road traffic" and permitting drivers to engage in non-driving behaviors in the future.

- The "Bill to Revise Part of the Road Traffic Act " was submitted to the 198th ordinary session of the Diet (*approved on May 28, 2019), which improves the regulations concerning the obligations of drivers etc. corresponding to the practical application of automobile automated driving technologies.
- Regarding the consideration of measures required to guarantee that automated driving systems comply with the norms set forth in road traffic laws and regulations, a provision was included in the Bill to Revise Part of the Road Traffic Act to define the automated driving devices stipulated under the Road Transport Vehicle Act as "automated driving devices" (*approved on May 28, 2019) based on the fact that a provision was included to newly add automated driving devices to the safety regulations in the "Bill to Revise Part of the Road Transport Vehicle Act."
- Regarding the state of penalties for a deviation from the norms of the road traffic laws and regulations during automated driving, the following is a summary of the "Research Report Directed at the Realization of Automated Driving Based on the Direction of Technology Development" (as pertains to the state of the Road Traffic Act).
  - In the unlikely event that driving violates the road traffic laws and regulations during automated driving due to a malfunction or defect, the negligence shall be specifically determined according to each individual case.
- Regarding the revision of obligations for existing drivers and the obligations of drivers using automated driving devices, the "Bill to Revise Part of the Road Traffic Act " (*approved on May 28, 2019) incorporates language which excludes the application of provisions which prohibit the use of mobile telephones (addition to the duty to drive safely) only in cases where the driver is able to immediately and appropriately respond under conditions (set by the Minister of Land, Infrastructure, Transport and Tourism) where the automated driving devices is no longer used.
- Regarding the examination of obligations which should be newly imposed on drivers, the "Bill to Revise Part of the Road Traffic Act " (*approved on May 28, 2019) defines the automated driving devices stipulated under the Road Transport Vehicle Act as "automated driving devices" and in regard to the obligations of drivers using automated driving devices, it incorporates language which prohibits operation that uses automated driving devices in the event that conditions (set by the Minister of Land, Infrastructure, Transport and Tourism) under which automated driving devices are used are not fulfilled.
- Regarding the examination of the storage and use of data during the operation of an automated driving vehicle, the "Bill to Revise Part of the Road Traffic Act" says that an

automobile which is equipped with automated driving devices must not be driven if it is unable to accurately record the corresponding information, because the "Bill to Revise Part of the Road Transport Vehicle Act" says that automated driving devices must be equipped with equipment to record the necessary information (*approved on May 28, 2019).

- Regarding the consideration of policies for the convoy length, driving speed, license required for driving, driving lane, handling (stopping so as not to affect other traffic, etc.) a situation where so-called "electronic towing (tentative name)" is severed during truck platooning with the trailing truck unmanned, the following is a summary of the state of traffic rules pertaining to field operational tests on public roads of truck platooning with the trailing truck unmanned using electronic towing in the "Research Report Directed at the Realization of Automated Driving Based on the Direction of Technology Development (Relationship Between New Technologies and New Services)."
  - In the event that electronic towing is severed, non-lead vehicles must be a system which can automatically and safely stop on the shoulder of the road. In this case, the driver of the lead vehicle must immediately stop the lead vehicle and implement safety assurance measures such as indicating that the trailing vehicles are also stopped.
  - Safety measures for merging into the main lane and measures to prevent other vehicles from easily cutting in must also be implemented.
  - The towing vehicle and the vehicle being towed must indicate on the front, rear, and sides according to the location and time of day that the vehicles are operating that the vehicles are platooning via electric towing so that the surrounding vehicles can easily understand.
  - The responsible organization shall appropriately manage the data for the test details and results and shall promptly provide the data to related organizations including the police as needed.
  - In the event that an emergency occurs during the field operational testing, an organization which can rush to the site must be maintained at the very least.
- Regarding the consideration of the "observance of the norms of the road traffic laws and regulations," "driver obligations," and "data storage and use," the following is a summary of the "Research Report Directed at the Realization of Automated Driving Based on the Direction of Technology Development (Relationship Between New Technologies and New Services)."
  - In the future, each company is likely to create a new business model. In consideration of the possibility of new business models, it is important to proceed with the discussion in a flexible manner.
  - Said transport services will take many different forms and summarizing them in a systematic manner to proceed with the discussion is a challenge. From the viewpoint of proceeding with the discussion pertaining to improvement of legal system, currently

each company is conducting field operational testing of various service arrangements to achieve their goals, and this is the stage in which they will likely determine what kind of needs, problems, and potential exist.

- Regional needs and the nature of the companies' business models are the keys to realizing said transport services, and the present time could be described as an important period for combining those elements. Considering solutions to the various problems identified through the field operational testing will likely propel them to early implementation.

➢ For the time being, field operational testing frameworks using remotely controllable automated driving systems can also be used during commercialization of transport services. However, the following arguments concerning issues for further safety assurances have been discussed in the Survey Review Board Directed at the Realization of Automated Driving Based on the Direction of Technology Development.

- Management system on the remote side (roles required of remotely monitoring operators, sufficient education and training to handle errors, etc.)
- Reporting when extraordinary cases occur
- Restrictions on driving speeds, etc. (safety measures based on the case where remotely monitoring operator response are required when the system is unable to recognize the dangers)

<Liability matters> (such as with respect to Act on Securing Compensation for Automobile Accidents, the Civil Code, the Product Liability Act, and Act on Punishment of Acts Inflicting Death or Injury on Others by Driving a Motor Vehicle, etc.)

We seek to clarify liability issues in the event of an accident and determine the causes of accidents in order to both enable the provision of prompt relief for victims in the unlikely event of an accident and have automated driving become accepted by society. We will investigate the acquisition, retention, and use of data toward this end.

i. The conventional liability of persons that put automobiles into operational use for that person's own benefit with respect to damages arising from an accident in the course of the utilization of an automated driving system shall be maintained in Act on Securing Compensation for Automobile Accidents.

ii. The Act on Securing Compensation for Automobile Accidents stipulates that it would be proper for damages due to an accident caused by hacking (where the owner of the automobile cannot be held liable as persons that put automobiles into operational use for that person's own benefit) to be handled through a governmental compensation fund just as with accidents

involving stolen vehicles, except where the automobile owner has not taken the necessary security measures.

iii. When commercializing an automated driving vehicle, studies on criminal liability shall be undertaken based on a clarification of roles and obligations expected of various concerned parties by, among others, traffic rules and legal systems concerning transportation businesses.

iv. The necessity of mandating the installation of data-recording devices, necessity of data recording functions, and necessity of mandating the submission of accident logs by an information owner shall be investigated by 2020.

- Progress and status as of the end of March 2019
  - The conventional liability of persons that put automobiles into operational use for that person's own benefit with respect to damages arising from an accident in the course of the utilization of an automated driving system shall be maintained in the Act on Securing Compensation for Automobile Accidents (already reflected in the Charter for Improvement of Legal System and Environment for Automated Driving Systems). In addition, because the insurance companies, etc. need to be able to ensure the effectiveness of the exercise of the right to remedy over from automobile manufacturers, it was decided in the amended law pertaining to automated driving that recording devices should be equipped to record the data which is needed to investigate the cause of an accident or discover a malfunction or defect in automated driving devices. Moreover, regarding the state of the system of cooperation between the insurance companies and automobile manufacturers, the concerned parties are discussing the policies for utilizing the recorded data and other issues.
  - An examination of the liabilities pertaining to software updates continues to be debated based on technology trends within the "Research and Development and Verification Program for the Social Implementation of Highly Automated Driving Systems: Research Concerning the Civil Liabilities and Social Acceptance of Automated Driving" project commissioned by METI and MLIT.
  - An examination of the relationship between the "expected general level of safety" and instructions and warnings, etc. during use is an ongoing subject of discussion based on technology trends, and we are examining how to proceed through discussion with the concerned ministries and agencies.
  - We would like to examine criminal liability based on the results of studying the clarification of the roles and obligations expected by various concerned organizations (drivers, users, onboard safety personnel, remotely monitoring operators, service providers, etc.) according to the contents of the amendments to the "Bill to Revise Part of the Road Traffic Act" (*approved on May 28, 2019) and other related laws and regulations, traffic rules, and the legal system concerning the transport industry.

- Regarding the examination of the mandatory installation of data recording equipment, based on the conclusion of the report of Sub-committee for Development of System for Advanced Technology for Automated Driving that the installation of equipment to record the operating condition of the automated driving system and the driver's condition as data is required, the decision was made to add "automated driving devices," including equipment for recording the information necessary to verify the operating condition, to the equipment covered under the safety regulations in the "Bill to Revise Part of the Road Transport Vehicle Act" which was submitted to the 198th ordinary session of the Diet (*approved on May 17, 2019).
- Regarding the examination of the data recording functions (data elements, recording interval/time, duration of retention, etc.), the specific items within the recorded details of the data recording equipment are being examined by taking into consideration the requirements which are genuinely necessary in cooperation with relevant agencies, ministries, and organizations, and the discussion will proceed among the concerned parties based on international trends.
- It was decided that it was not necessary to examine whether to make it mandatory for information owners to submit recordings when an accident occurs.

<Relationship to legal systems concerning transportation businesses>

Measures that need to be implemented when transporting passengers in an automated driving vehicle without a driver present shall be investigated.

- Progress and status as of the end of March 2019
  - Regarding the examination of measures required to ensure safety and convenience equivalent to conventional levels in the case of transporting passengers in an automated driving vehicle when the driver is not present, we are proceeding with discussions to formulate guidelines (tentative name) for passenger automobile transport businesses to ensure safety and convenience in driverless automated driving transport services in specified areas.

<Other matters>

Required matters concerning various types of infrastructure, such as infrastructure for vehicle-to-infrastructure cooperation and other, and explanations for consumers shall be studied.

- Progress and status as of the end of March 2019
  - Regarding practical application and the examination of displays which allow others to determine that a vehicle is currently engaged in automated driving based on the vehicle's

appearance, after figuring out the situations in which it would be necessary to inform pedestrians and other nearby traffic participants that a vehicle was driving automatically and communicate between the automated driving vehicle and the pedestrians and other nearby traffic participants in the report of Sub-committee for Development of System for Advanced Technology for Automated Driving announced in January 2019, it was concluded that we should advance the discussion regarding the formulation of an international regulation in the WP29. The following is a summary of the "Research Report Directed at the Realization of Automated Driving Based on the Direction of Technology Development" (as pertains to the state of the Road Traffic Act).

- While it is desirable to require external displays to be shown only during automated driving from the perspective of securing overall traffic safety and security, an examination is required based on the discussions pertaining to international regulations for automated driving vehicles and the impact, etc. on peripheral transportation groups.

- An examination of the impact on the health of long-distance truck drivers (because it is expected that automated driving on the expressway will reduce the burden on the driver) will be conducted after platooning and automated driving, etc. are released to the market and a certain quantity of health data has been collected.
- The following initiatives are currently underway to examine the types of equipment and communication infrastructure (including vehicle-to-infrastructure cooperation) which need to be installed on roadways to complement the safety of automated driving vehicles.
  - The regulations and improvements of legal system to ensure road spaces which support automated driving and the legal positioning of magnetic markers etc. used in vehicle-to-infrastructure cooperation technologies have been raised as items pertaining to the use of road spaces which support automated driving that should be undertaken for the nationwide deployment from 2020 in the "Interim Summary of the Committee to Investigate Field Operational Tests of Automated Driving Business Models Using Roadside Stations in Hilly and Mountainous Areas as a Hub" (January 23, 2019).
  - Based on the field operational testing results of automated driving services using roadside stations in hilly and mountainous areas as a hub and truck platooning on expressways, we will examine the state of dedicated and priority spaces for automated driving vehicles and the regulations and legal systems, etc. of road spaces which support automated driving including vehicle-to-infrastructure cooperation technologies.
  - In the second phase of SIP-adus, roadside infrastructure is being set up to provide vehicles with signaling information and merging assistance information, etc. to carry

out field operational testing of vehicle-to-infrastructure cooperative system in the Tokyo waterfront area.

- Regarding the provision of signaling information for automated driving, we are examining the advancement of roadside infrastructure and methods using the cloud, etc. based on studies by automobile manufacturers, etc.
- We are examining the construction of mechanisms and systems to provide information from the roadside which supports the implementation of automated driving such as the traffic conditions in the traffic lane of the merging destination which is required for automated driving in the emerging section of an interchange. Furthermore, the results of this examination shall be used to improve the environment or the field operational testing in the Tokyo waterfront area.
- The following is a summary of the desirable road transport environment improvements to achieve an automated driving society in the "Research Report Directed at the Realization of Automated Driving Based on the Direction of Technology Development (Relationship Between New Technologies and New Services)."
  - ✧ Based on the transitional arrangement of having automated driving vehicles "inserted" into the existing transportation society, the fundamental view should be that maintaining a safe and smooth road transport environment for conventional traffic participants will lead to the creation of a road transport environment that also makes it easy for automated driving vehicles to drive as a result.
  - ✧ It would be advisable to develop a system to alert manually-driven automobiles and other traffic entities to the presence of automated driving vehicles at intersections with poor visibility.
  - ✧ It would be advisable to develop a system to provide signaling information using radio waves etc. not only to ensure the reliability of driverless automated driving transport services but to also ensure the safety of passengers by preventing the need for the system to suddenly brake.

➢ Regarding the examination of points to consider when explaining the risks and usage to consumers at the time of sale, discussions are continuing at events such as the "Research Concerning the Civil Liabilities and Social Acceptance of Automated Driving" symposium hosted in March 2019, under the "Research and Development and Verification Program for the Social Implementation of Highly Automated Driving Systems" project commissioned by METI and MLIT.

➢ In order to promote understanding of automated driving among general citizens and the use of automated driving with service providers, we are conducting activities to cultivate social acceptance such as hosting a symposium and an "Automated Driving Future

Showcase" in February 2019 to present panel exhibitions and videos including actual cars using automated driving technologies, simulator-based demonstrations, and other interactive contents as a summary of the results achieved by the first phase of SIP-adus over the past five years.

<Promotion system and way of moving forward in the future>

Based on the fact that automated driving related technologies are rapidly progressing, follow-up meetings will continue to be held every half year, and institutional reviews will be subject to ongoing studies.

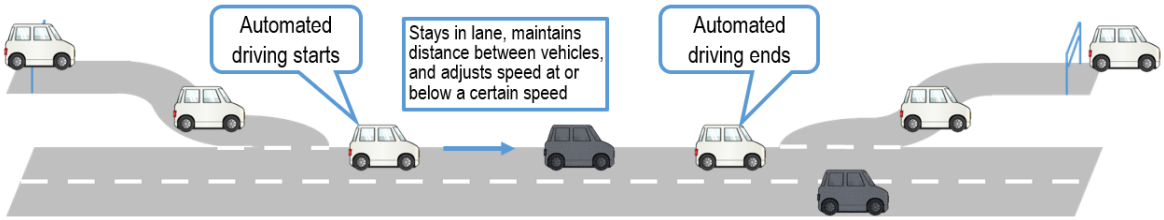
B. Private vehicle initiative

<Vision of automated driving realized in 2020 - Automated driving on expressways (Level 3)>

The following defines the minimum requirements which must be satisfied as part of the "Circa 2020" vision for realizing automated driving on expressways. However, due to the technology development efforts of manufacturers and other companies, the vision may be achieved with a broader scope.

- Able to start automated driving on a main roadway
- Automatically lane keeping, adaptive cruise control, and speed adjustment at a certain speed or below
- Able to finish automated driving on a main roadway

Figure 10: Vision of automated driving with private vehicles realized in 2020



The Cabinet Office conducted large-scale field operational testing of five important issues including dynamic maps in the first phase of SIP-adus from October 2017 to December 2018. In the second phase of SIP-adus, field operational testing of vehicle-to-infrastructure cooperative system is being conducted in the Tokyo waterfront area.

Table 5: Overview of the first phase of SIP-adus large-scale field operational tests

Test location	Test contents
Expressway	• Validating high-precision 3D map data relating to curves and various other types of road configurations, course environments, structures, and other such elements; • Validating linkages between congestion information, construction information, and other forms of dynamic information with dynamic maps; • Testing HMI in terms of driver condition assessments; and more.
Ordinary road	• Validating usability and effectiveness with respect to mobility support, such as in terms of controls to ensure the precise stoppage of buses and the sharing of route information through pedestrians' mobile devices; • Validating the usability and express performance of public buses that operate based on the use of ART technologies to collect and amass traveling data at the ART Information Center and share information with users.
Testing laboratory, etc.	• Validating the method by which information security evaluations are conducted.

Moreover, in the first phase of SIP-adus, we have addressed institutional issues (examining the necessity of the HMI-related guidelines in light of the issue of overconfidence where drivers have too much confidence in the system's capabilities and put themselves at higher risk of accidents), issues related to social acceptance social acceptance (promotion of understanding among drivers involved in automated driving and consumers), and issues related to technologies and infrastructure (development of dynamic maps and information and communications infrastructure).

Automated driving on ordinary roads (level 2)

We will commercialize automated driving systems (Level 2) that enable driving even in automated driving modes on ordinary roads by expanding the areas where automated driving systems function based on Level 2 automated driving systems that will be commercialized for expressways.

Specifically, we aim to realize automated driving systems (Level 2) that enable straight driving on major highways (national roads and major local roads) around 2020. Then, it is expected that ODDs of Level 2 automated driving systems will be expanded around 2025, enabling right and left turns on major highways and straight driving on other roads.

Highly/fully automated driving on expressways

In light of the realization of semi-autopilot and autopilot by 2020, we aim to commercialize automated driving systems for expressways (Level 4) in 2020.

In automated driving systems for expressways (Level 4), automated driving is available from the entrance to the exit of an expressway, and the driver can either override the system as needed or let the system operate. The vehicle must automatically pull over to the side of the road when it exits

ODDs, i.e., the specific conditions under which the automated driving system is designed to function, or in case of abnormalities (Minimal Risk Maneuver (MRM)[22], etc.).

In order to support automated driving at diverging and merging sections on expressways and in other complex traffic environments, MLIT began, at January, 2018, joint public-private sector research on schemes for sharing information from road-side sources and will continue to promote studies undertaken jointly by public- and private-sector entities.

In addition, the second phase of SIP-adus started in 2018 will entail the promotion of research and development activities in cooperative area by members of academia, the government, and industry working in tandem in line with the expected timing of the popularization and commercialization of automated driving as set forth in the Initiative/Roadmaps (when the focus is also slated to be newly directed at the further development of driver assistance technologies in private vehicles for use on ordinary roads and automated driving technologies in private automobiles for use on expressways, as well as services for logistics and transport services), which will in turn lead to the formation of a sustained system of collaboration by members of academia, the government, and industry. Due to the need to provide signaling information and merging assistance information from infrastructure and highly up-to-date road traffic information using vehicle probe information in order to further advance automated driving technologies, public and private partnerships are undertaking the construction of this information while also continuing to undertake the development of technologies pertaining to cooperative areas including safety assessment technologies, the cultivation of social acceptance, and the strengthening of international cooperation for the practical application and commercialization of automated driving.

Popularization of driving safety support systems

Considering it will take time to commercialize, service, and popularize the automated driving systems mentioned above, we need to address measures to popularize driving safety support systems with an eye on establishing a society with the world's safest road transport and the world's best ITS by 2020.

Considering the fact that the prevention of traffic accidents by the elderly drivers is an urgent issue, the government announced "the Interim Report of the Meeting of Senior Vice Ministers of Relevant Ministries on driving safety support vehicle" in April 2017. The report specifies the definitions of driving safety support vehicles for the elderly drivers, which are shown in Table 6 Based on these definitions, we will work on the promotion of popularization and public recognition of driving safety

22 Technology that enables the vehicle to transition to a minimal risk condition automatically and safely in case of abnormalities. It is essential to develop and adopt such technology in order to realize fully automated driving (Level 4) and sophisticated driving safety support systems (tentative name.)

support vehicles, improving and expansion of vehicle assessment, and development regulations for advanced safety technologies, utilizing various public relations tools.

Table 6: Definitions of Safety Support Car S

Wide	Advanced Emergency Braking Systems (pedestrian detection), Sudden Unintended Acceleration Prevention System Lane departure warning, advanced lights
Basic+	Advanced Emergency Braking Systems (vehicle detection), Sudden Unintended Acceleration Prevention System
Basic	Low-speed Advanced Emergency Braking Systems (vehicle detection), Sudden Unintended Acceleration Prevention System

In addition to the efforts for the popularization of Safety Support Car S for the elderly drivers mentioned above, the government and private sectors will jointly work on promoting the popularization and public recognition of vehicles with Advanced Emergency Braking Systems (AEBS) and other safety features, giving it the nickname "Safety Support Car," to help prevent traffic accidents by all drivers.

In addition, based on an interim summary in a meeting at MLIT of Senior Vice Ministers from related agencies and ministries concerning public recognition about driving safety support vehicles, Japan established a system in March 2018, based on requests from automobile manufacturers, etc. to certify that passenger car Advanced Emergency Braking Systems (AEBS) possess a certain level of performance, and as of the end of April 2019, the performance of 152 models has been certified based on applications from eight Japanese manufacturers. Moreover, automobile manufacturers, etc. created a logo mark which can be used in public relations activities to promote the popularization of Advanced Emergency Braking Systems (AEBS), which will be further promoted through initiatives by public-private partnerships.

In addition to promoting driving the safety support vehicles mentioned above, we will promote measures for the popularization of various driving safety support systems and information provision systems, as shown in Table 7.

Table 7: Promotion of measures related to driving safety support systems (other than driving safety support vehicles)

- Further popularization and sophistication of Automatic Collision Notification System (ACN) and the Emergency Call System (HELP), which enable drivers to report accidents using their on-board device or mobile phone
- Popularization and utilization of on-board devices such as driving video recorders and event data recorders, from which information can be obtained to understand and analyze accident situations
- Preparation for the introduction of Driving Safety Support Systems (DSSS), which provides visual

and audio information on surrounding traffic situations to the driver utilizing the infrastructure of traffic control systems, and the Traffic Signal Prediction Systems (TSPS), which provides prior information on which signal is on when the vehicle arrives at an intersection with traffic signals.

- Efforts to realize smooth, safe, and secure road transport based on the use of ITS technologies, such as through the popularization and promotion of ETC 2.0 and advanced optical beacons, as well as through an expansion of the utilization of ETC and other forms of ITS technologies at private parking lots and other facilities not constituting expressways.
- Joint considerations among government, academia, and industry on more effective measures against driving the wrong direction on expressways such as prompt detection of vehicles driving in the wrong direction, provision of warning on the road or inside the vehicle, and utilization of automated driving technologies
- Development of vehicle-to-pedestrian communication technologies useful for reduction of pedestrian accidents, and others.

Realization of sophisticated driving safety support systems (tentative name)

In order to achieve traffic accident prevention at a higher level, it is necessary to develop vehicles with sophisticated driving safety support systems (tentative name) and that cause almost no accidents not only by improving the level of driving automation but also by further sophisticating existing technologies [23] related to vehicle safety and utilizing automated driving technologies, while assuming that the driver will operate the vehicle. Such vehicles are considered to contribute not only to the reduction of traffic accidents but also to the strengthening of competitiveness of Japan's auto industry by providing added value to consumers as vehicles that enable drivers to enjoy driving safely.

Though specific technical specifications of sophisticated driving safety support systems will be discussed in the future, we aim to sophisticate individual technologies including Minimal Risk Manuever (MRM) such as more advanced damage reduction braking and Emergency Driving Stop System (EDSS)[24] and integrate such technologies into a system by adopting artificial intelligence (AI) and driver-friendly interfaces (HMI). In addition, this also includes the advancement of cooperative information gathering technologies (including the development and advancement of information and communications infrastructure).

In light of industrial trends in technology development, we aim to specify concrete specifications by cooperating with public and private sectors where necessary and realize vehicles with sophisticated driving safety support systems (tentative name) around the mid-2020s (by 2025.)

23 Including technologies called Advanced Driver Assistance Systems (ADAS).
24 MLIT announced the world's first guidelines for Emergency Driving Stop System (EDSS) of deceleration stop type in March 2016, and the one of road shoulder retreat type in March 2018.

Table 8: Specific element technologies of "sophisticated driving safety support systems (tentative name)" (image)

For example, sophistication of individual automated driving technologies will be promoted as described below, and these technologies will be integrated into a system that includes AI and HMI technologies.

- Further advancement of Advanced Emergency Braking Systems (AEBS)
  - ✓ Drastic expansion of the distance between the vehicle and an obstacle and the speed that Advanced Emergency Braking Systems (AEBS) can detect
  - ✓ Drastic improvement of fail-safe functions in collaboration with an Sudden Unintended Acceleration Prevention System[25]
- Sophistication of Emergency Driving Stop System (EDSS) (including Minimal Risk Maneuver (MRM))
  - ✓ Promotion of development from the push-button type to the automatic detection type and from the simple/in-lane stop type to the roadside stop type
- Others (Keeps lane assist etc.)

C. Logistics service initiatives

<Illustration of the implementation of truck platooning on expressways>

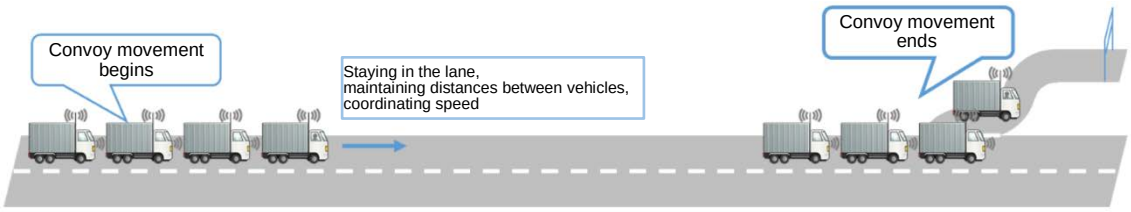
The vision for the implementation of driver-assistive truck platooning "by 2021" anticipates the following.

- Uses CACC[26]+LKA technologies and follows the vehicle ahead of it
- Both the lead vehicle and the trailing vehicle operate under the responsibility of each vehicle's driver
- The trailing vehicle follows the lead vehicle and automatically executes lane keeping, adaptive cruise control, and speed adjustment to help the driver of the trailing vehicle drive
  - ➢ Starts on a main roadway (follows the lead vehicle)
  - ➢ In addition to being able to cancel the platooning at any time, the trailing vehicle exits the platooning when the lead vehicle/trailing vehicle changes lanes or separates, etc.

25 A device that prevents rapid acceleration by controlling engine output if the accelerator pedal is applied when the on-board radar detects a wall or a vehicle

26 CACC (Cooperative Adaptive Cruise Control): System that adds vehicle-to-vehicle communications to ACC (adaptive cruise control, which constitutes a technology that uses radar measurements to maintain a proper distance to the vehicle in front) to share information on the acceleration/deceleration of other vehicles and thereby engage in more precise inter-vehicle distance control. It has already been commercialized.

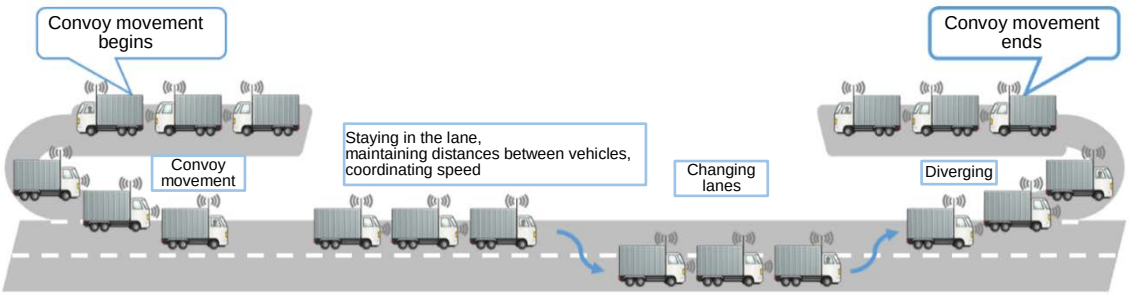
Figure 11: Illustration of the implementation of driver-assistive truck platooning



Moreover, the vision for the implementation of truck platooning with the trailing truck unmanned "after 2022" anticipates the following.

- Platooning using so-called "electronic towing (tentative name)" based on current towing
- Both the lead vehicle and the trailing vehicle operate under the responsibility of the lead vehicle's driver
- The trailing vehicle is towed electronically and executes speed adjustment, adaptive cruise control, lane keeping, lane change, and drives while unmanned
  - Create the convoy off of the main roadway and start platooning (convoy with a maximum of three vehicles)
  - Merge onto the main roadway
  - Separate from the main roadway
  - Release the convoy off of the main roadway and stop platooning

Figure 12: Illustration of the implementation of platooning with the trailing truck unmanned



In order to realize truck platooning, we must take steady steps in cooperation with concerned parties including related ministries and agencies, since there are many important issues to solve such as the impact on surrounding traffic environments and road structures as well as technical issues (safety of electronic coupling, securing of reliability, etc.) and institutional issues (technical requirements, traffic rules, etc.)

In order to technically implement truck platooning with the trailing truck unmanned on expressways in FY2020, METI and MLIT are promoting an initiative for the purpose of examining

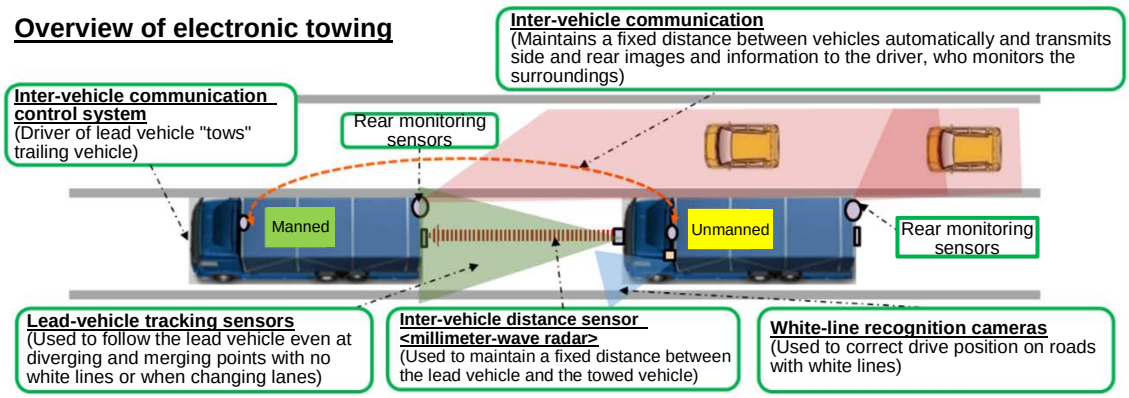
the requirements and frameworks required for the development of the vehicle technologies and to establish/continue them as a business. After conducting the world's first field operational testing of driver-assistive truck platooning using truck CACC systems manufactured by different companies on the segment of public roads between the Enshu-Morimachi PA and the Hamamatsu SA on the Shin-Tomei Expressway in January 2018, various field operational testing has been conducted, and field operational testing of truck platooning with the trailing truck unmanned (trailing truck in manned state) began in January 2019.

Field operational testing of platooning with the trailing truck unmanned using electronic towing is scheduled to start in FY2019 after the technology development and test course verification. The testing will verify whether the system can safely drive under various conditions including malfunctions and poor weather.

Moreover, MLIT started an examination concerning the utilization of expressway infrastructure which supports new logistics systems in a committee on December 21, 2018, to promote a specific investigation of utilization policies for expressways infrastructure centering on the Shin-Tomei expressway based on past tests[27]of platooning on the test course and the status of double truck operation.

Based on the above, we aim to expand traveling distance and range through repeated testing after realizing a system of truck platooning with the trailing truck unmanned on expressways (Shin-Tomei Expressway) in FY2020, and thereby commercialize truck platooning with the trailing truck unmanned for long-distance transportation on expressways (between Tokyo and Osaka) in or after FY2022.

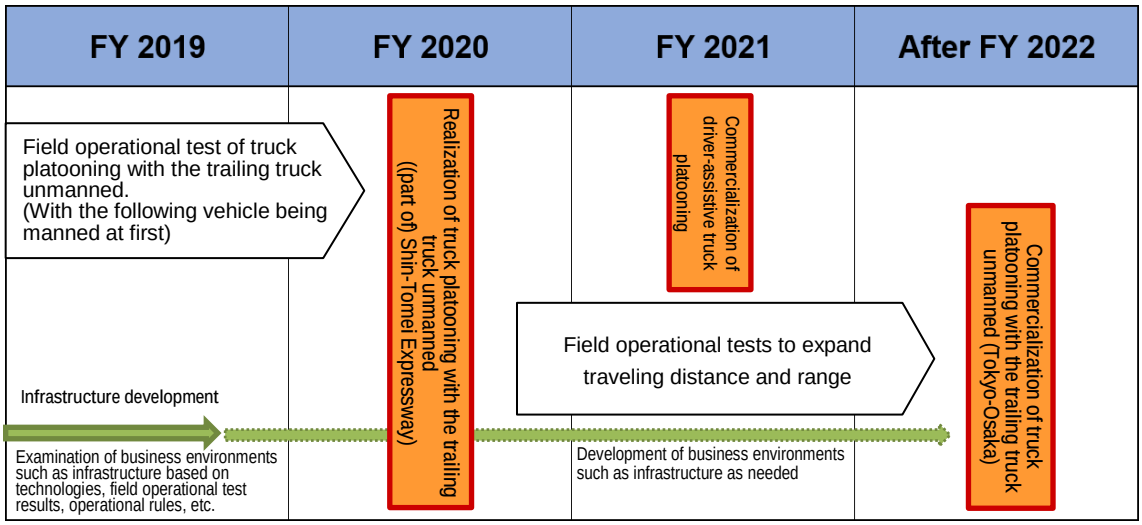
Figure 13: Illustration of electronic towing



27 R&D for Automated Driving and Platooning, Development of Energy-saving ITS Technologies (July 2010 to March 2015, by NEDO)

With a view to contributing to the development of a system of truck platooning with the trailing truck unmanned, we aim to first commercialize a realistic system of driver-assistive truck platooning by 2021.

Figure 14: Schedule for realization of truck platooning on the expressways (overview)



Realization of fully automated driving trucks[28] on expressways

As an effort to utilize automated driving systems, we will prioritize the realization of truck platooning on expressways described previously from the standpoint of technological ease.

However, given the fact that, with progress being made in terms of development work and field operational testing of fully automated driving systems for private vehicles, the results of such development work and testing are expected to be applied to trucks in the future as described in B. Given as well that many field operational tests are being conducted overseas by private companies[29] including venture companies to realize fully-automated driving trucks, and that fully-automated driving trucks on expressways are expected to not just solve the problem of driver shortages but also become more effective in reducing carbon dioxide emissions and improving the efficiency of road usage through the use of truck platooning, we should also ideally focus on commercialization and the promotion of services in Japan.

28 In the Initiative/Roadmaps 2019, trucks with fully automated driving systems are called fully-automated driving trucks.

29 Some overseas companies announced that they would commercialize such trucks in 2025. Some companies in Japan are also considering developing plans for the realization of fully-automated driving on expressways.

Thus, we will move ahead on the realization of fully automated driving trucks on expressways after 2025 in light of the technological progress of automated driving systems for private vehicles and results of field operational tests of truck platooning.[30]

Realization of driverless automated driving delivery services in specified areas

When realizing innovative, effective logistics, streamlining not only transport on highways such as expressways but also the logistics for small-lot delivery including delivery to users is an urgent issue. Due to this, Japan has started conducting field operational tests on the utilization of automated driving for delivery services by private companies.

We aim to realize unmanned automated delivery services in specified areas after 2020 by applying the technologies of driverless automated driving transport services in specified areas shown in D. Specifically, for example, it is expected that both-way transport between a center and a settlement in underpopulated areas and door-to-door delivery services in settlements will be realized, and then service recipients and areas will be expanded.

In addition, after it will become possible to offer transportation services based on the use of automated driving vehicles in underpopulated areas, where the consolidated freight and passenger is now possible under certain conditions in September 2017, it is conceivable that both passenger transportation and cargo transportation services will be provided using the same vehicle.

D. Transport service initiative

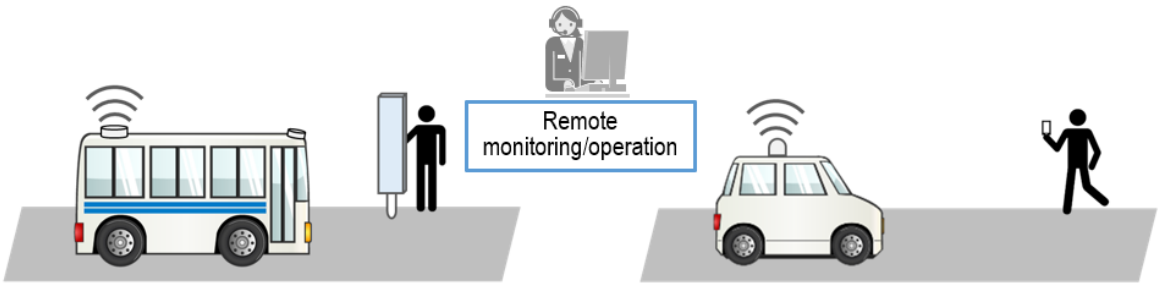
<Vision of the automated driving implementation in 2020 - automated driving transport services using the field operational testing framework>

The following defines the minimum requirements which must be satisfied as part of the automated driving transport services using the field operational testing framework.

- Comparatively simple ODDs
- One person remotely monitors and operates one vehicle or multiple vehicles
- In the event that the ODD is exceeded, the vehicle promptly suspends operation and the remotely monitoring operator or service provider in the vehicle implements the required measures

30 The timing of realization needs to be examined based on the progress of development, operational tests, and realization of automated driving systems for private vehicles and truck platooning by and considerations of business operators.

Figure 15: Vision of transport services realized in 2020



Institutional efforts[31] required to conduct field operational tests of driverless automated driving transport services in specified areas on public roads have been steadily implemented in accordance with the Road Traffic Act and the Road Transport Vehicle Act, which enable field operational tests of remotely controllable automated driving systems on public roads that can be conducted under the current Convention on Road Traffic[32].

Field operational tests on public roads have been conducted in National Strategic Special Zones with an eye to realizing fully automated driving. In addition to such tests, many government-led field operational test projects for the realization of automated driving services in specified areas such as “Field Operational Test for Social Implementation of access trip” by METI and MLIT and “Field Operational Tests of Automated Driving Service Conducted at the Roadside Station - Michi no Eki, as a Base in Hilly and Mountainous Areas as a Hub” and "Improving the Environment Toward Practical Application of Transport Services Based on Automated Driving in Regional Areas" by MLIT/Cabinet Office SIP were conducted since June 2017. In addition to government-led projects, field operational tests of automated driving systems and discussions on their implementation are being conducted by local public organizations, universities, etc. in regions across the country.

In addition, based on the improvement of legal system mentioned above, we started field operational tests of remotely controllable automated driving systems on public roads from FY2017.

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31 The National Police Agency formulated the "Regulations Applicable to the Handling of Applications for approval for use of road to the Field Operational Testing of Remotely Controllable Automated Driving Systems on Public Roads" in June 2017. Moreover, because the Public Safety Commission rules for prefectures across the country were amended, field operational testing of remotely controllable automated driving systems on public roads in which the driver does not ride in the driver's seat of the test vehicle became an action which falls under the road use permissions of Article 77 of the Road Traffic Act, which made it possible to implement such testing under the road use permissions.
The MLIT revised related laws and regulations based on the Road Transport Vehicle Act in February 2017. Due to this revision, the safety regulations have been relaxed on vehicles with no steering wheel or accelerator pedal on the premise that safety is secured in order to enable field operational tests of driverless automated driving transport services in specified areas on public roads.

32 At the 72nd meeting (held in March 2016) of UNECE Working Party on Road Traffic Safety (known as WP1. The name was changed to the Global Forum for Road Traffic Safety in February 2017) under the United Nations Economic and Social Council, the opinion that “testing of driverless vehicle is possible under current treaties where there is a person who is ready and able to take control of the experimental vehicle(s); this person may or may not be inside the vehicle” was formulated as a result of discussions on automated driving by the informal working group, and WP1 accepted it.

After commencing field operational testing on public roads on a 1-to-1 basis where one remotely monitoring operator monitors one vehicle and assuming that safety can be ensured based on an accumulation of data obtained from a series of field operational tests conducted on public roads, we will decide to proceed to field operational testing on public roads on a 1-to-N basis where one remotely monitoring operator monitors multiple vehicles at the same time[33].

In addition, while we tried to specify requirements for dedicated spaces and driving methods in 2017 to promote field operational tests of driverless automated driving transport services in specified areas outside public roads, we realized that driverless automated driving transport services in dedicated spaces may be provided using fully-automated driving systems with no remotely monitoring operator in the future. For such driverless automated driving transport services, we aim to expand automated driving businesses in the private sector from 2020 onwards by confirming social acceptance through field operational testing beginning in FY2017 and conducting longer-term field operational testing with a view to commercialization, in collaboration with concerned business enterprises in order to build a proper business model.

Based on these field operational tests on public roads, the goal is to implement driverless automated driving transport services by 2020, and to do so we will establish Minimal Risk Maneuver (MRM).

After that, we will work on realizing a society that enables the elderly drivers to freely move around the country by around 2025 by expanding driverless automated driving transport services across the country, while improving technology levels (including expansion of ODDs) and expanding service contents.

Furthermore, stable business models must be established to transition from the testing stage to the implementation stage. For example, the types of field operational testing which are currently being conducted include (1) tourism, (2) hilly and mountainous areas, (3) urban areas, (4) new town (old new town), (5) exclusive roads, and (6) the automation of existing fixed-route buses. It is believed that in many cases it will be challenging to make a profit with just transport services based on automated driving, but consideration of the following is required going forward.

- Linking with other services

  Increase profits overall by linking with other services (tourism, dining, etc.)
  (Therefore, build infrastructure to link various services with mobility data)

33 To date, "1-to-1" field operational tests have been performed on public roads in Tokyo, Aichi Prefecture, Ishikawa Prefecture, Kanagawa Prefecture, and Fukui Prefecture (as of June 2019). Moreover, field operational tests on public roads in which one remotely monitoring operator monitors two automated driving vehicles have also been conducted in Fukui Prefecture (from November 2018) and Aichi Prefecture (from February 2019).

- Supplementing with infrastructure

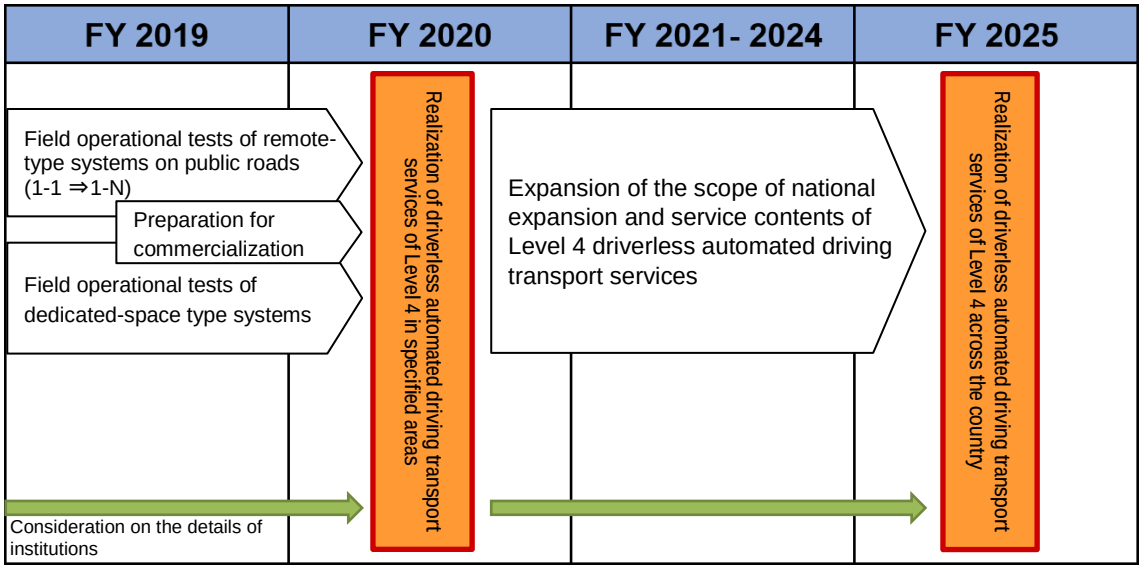
  Restrain the overall investment amount by increasing safety on the infrastructure side to avoid expensive technology investment (dead track sites and other exclusive/priority driving spaces etc.)

- Reducing the deficits of local public organizations

  Even if the overall profits do not produce a surplus, introduce automated driving as public transportation for the purpose of reducing the burden of local public organizations in maintaining public transportation which is operating at a deficit

It is important to create successful examples of sustainable business models by considering these ideas and deploying them nationwide.

Figure 16: Schedule for realization and popularization of Level 4 driverless automated driving transport services (summary)



Advanced Rapid Transit (ART)

Our challenge with regard to the 2020 Tokyo Olympics and Paralympics is to achieve stress-free Olympics by improving accessibility from the coastal areas that have a relatively inconvenient transportation system to downtown Tokyo, and by developing universal transportation infrastructure that facilitates the mobility of all people, including wheelchair and stroller users.

To this end, based on the operation schedule for the Practical Application of the Advanced Rapid Transit (ART)[34] for the Development of Tokyo and the Aging Society, ART shall be promoted. Such efforts shall be promoted with regard to the 2020 Tokyo Olympics and Paralympics as a milestone and aiming at the ultimate goal of deploying the system across Japan.

<Automated valet parking[35]>

Currently, automated parking, where vehicles are automatically steered into parking spaces, is being put into practical use. On the other hand, there is a strong need for automated valet parking, where the driver gets out of the car, for example, in front of a store, and the car runs without the driver into the parking lot of the store, finds an empty space, and parks itself in the space, due to the parking lot owners' desire to improve parking lot management efficiency and enhance safety in parking lots and customer satisfaction.

We aim to realize automated valet parking in dedicated parking lots (separated from general traffic, installation of a control center) for vehicles compatible with the automated valet parking from around 2020, assuming its application to rental car services in tourist areas and commercial vehicle leasing services. To this end, efforts toward the formation of a consensus among concerned parties and continued international standardization of the automated valet parking shall be promoted through field operational tests of automated valet parking, which were conducted in FY2018. In addition, we assume such a system will develop into an automated valet parking in general parking lots with social implementation of fully-automated driving systems.

E. Securing of social acceptance and development of a society-wide collaboration system

<Overall social framework for securing social acceptance>

In Japan, a prerequisite for building the world's most advanced ITS in specific regions and expanding it across the nation is that citizens who will use and live with ITS/automated driving participate in the efforts to build such systems with a prior understanding of the social costs for their introduction and their limitations as well as the benefits given by them. In particular, when introducing automated driving systems into society as a new technology, it is indispensable not only to develop institutions as mentioned above but also to secure social acceptance.

34It was discussed at the meeting of the Task Force on Science, Technology, and Innovation for the 2020 Tokyo Olympics and Paralympics, which was established under the Council for Science, Technology and Innovation in FY2014.

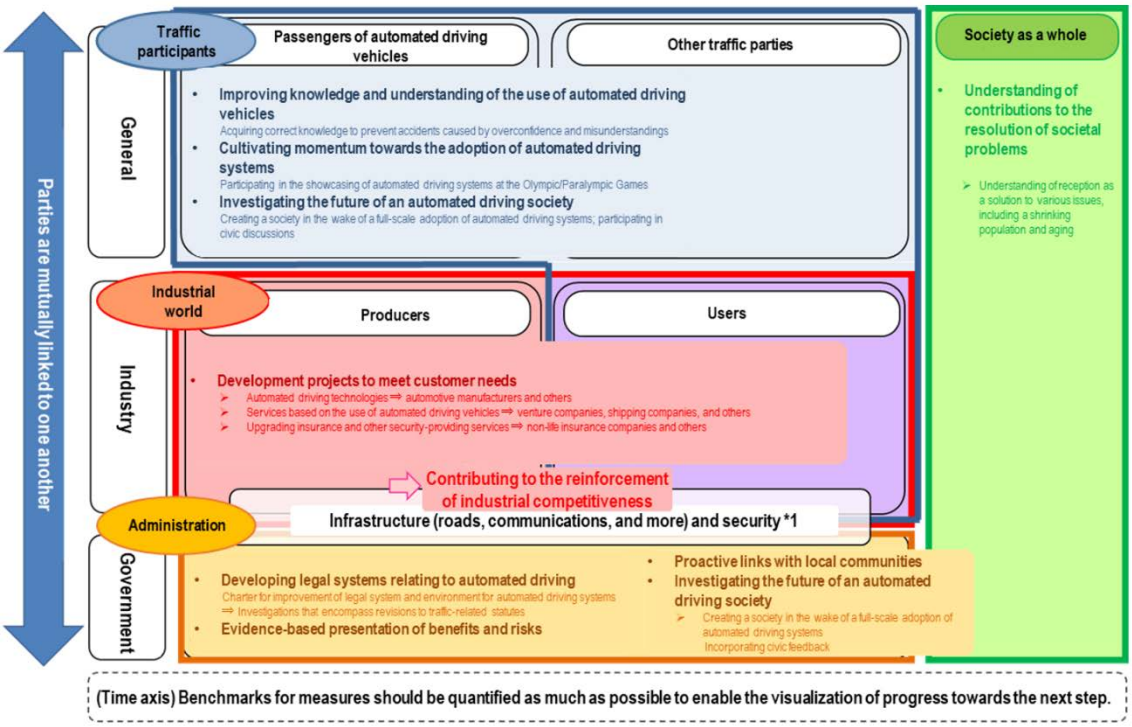
35 Automated valet parking is a system that is supposed to be utilized for private vehicles. However, since it is an automated driving system that is utilized in highly specified areas, and it will be introduced starting from commercial vehicle services, we included it in “D Transport service initiative.”

Issues related to the securing of social acceptance have recently become evident, since there have been problems not only in the case of automated driving systems of level 3 and higher and above but also in technologies related to automated driving corresponding to Level 1-2 that have already been commercialized.

With the impending arrival of the time for commercialization and service realization corresponding to Level 3 or above, we will need to clarify the stakeholders that pertain to ITS and automated driving and define the roles that should be fulfilled by each stakeholder in order to secure social acceptance.

These stakeholders and the initiatives that should be carried out by each stakeholder are outlined below.

Figure 17: Initiatives to be undertaken by each stakeholder to secure social acceptance



*1: It is assumed that roads, communications, and other infrastructural elements as well as security tools and measures will be developed by industry and/or the government.

Stakeholders pertaining to ITS and automated driving are categorized as set forth in Table 9.

Table 9 Categories of stakeholders pertaining to ITS and automated driving

i.	Traffic participants Refers to all parties participating in road traffic. For example, this term includes common individuals who own and drive their own automated driving vehicles as well as

transportation business operators, logistics companies, and other operators of businesses that utilize automated driving vehicles and their passengers.

Likewise, this term refers to common individuals who own and drive conventional vehicles not equipped with an automated driving system (hereinafter referred to as "non-automated driving vehicles") as well as operators of businesses that utilize non-automated driving vehicles and their passengers. Also included in this term are non-automotive traffic participants, such as cyclists and pedestrians.

ii. Industry

Refers to automotive manufacturers, parts manufacturers, and other parties involved in the production of automobiles, both automated driving vehicles and non-automated driving vehicles, as well as transportation business operators, logistics companies, and other operators of businesses that utilize automated driving vehicles and businesses that are linked to the provision of automobile insurance (plan).

iii. Government

Refers to the national government and local governments as administrative bodies.

iv. Society as a whole

In addition to i through iii above, refers to society as a whole, inclusive of parties that are not directly involved with automated driving vehicles. For example, the recipients of packages delivered by shippers utilizing automated driving vehicles.

※ A single party may come under multiple categories. (For example, a person working for an automotive manufacturer would come under multiple categories as both an industry player and a traffic participant.)

In seeking to secure social acceptance, it is believed that various initiatives will need to be undertaken by these stakeholders as outlined below.

i. Traffic participants

Traffic participants will need to improve their acquisition of knowledge and level of understanding with respect to the use of automated driving vehicles irrespective of whether or not they personally use automated driving vehicles. We expect that correct knowledge of automated driving vehicles can help prevent accidents caused by overconfidence in or misunderstandings of automated driving functions and lead to the securing of social acceptance on the part of society as a whole.

General traffic participants will also need to be involved in cultivating momentum for the adoption of automated driving systems by helping to showcase automated driving systems to an international and domestic audience through the use of automated driving vehicles at the Olympic and Paralympic Games and at other such times, and participating as citizens in discussions and studies concerning the approach society should take in the wake of the adoption of automated driving systems.

ii. Industry

In the realm of industry, it is expected that automated driving-related products and services tailored to meeting customer needs will be developed. In addition to improvements to automated driving technologies in terms of the technology itself, we expect to also see social acceptance

secured and the competitiveness of the Japanese automotive-related sectors bolstered through the development of various attractive services based on the use of automated driving vehicles, the development of insurance products for automated driving vehicles so as to promote the safety of automated driving vehicle users, and the development of a business model to facilitate the provision of various services based on the use of automated driving vehicles with a view to creating new businesses.

iii. Government

The national government will improve the regal system relating to automated driving, inclusive of the investigation of revisions to traffic-related statutes as set forth in a Charter for Improvement of Legal System and Environment for Automated Driving Systems. The national government and local governments are expected to proactively join forces to promote the development of infrastructural environments, make evidence-based presentations of the benefits and risks of adopting automated driving systems, investigate the framework for promoting proactive participation on the part of local residents and businesses in field operational testing and commercialization initiatives, and accelerate initiatives that are focused on the future of an automated driving society in which traffic participants and society as a whole are involved. Moreover, we will strive to educate drivers about the important points to consider when driving by coordinating with automobile manufacturers and dealers, etc. for the safe market introduction of automated driving vehicles.

iv. Society as a whole

In society as a whole, we will need to ascertain the extent to which automated driving can be effective as a solution to local depopulation, aging, and other such issues based on the evidence outlined in iii above, and cultivate an understanding that automated driving can help solve such societal issues.

<Specific initiatives for securing social acceptance>

In order to endeavor to improve social acceptance pertaining to ITS/automated driving systems, operators that provide such products and services must provide their consumers with appropriate knowledge of the benefits, effectiveness, new risks, and other pertinent details of such technologies by having them first understand their functions and performance. However, upon taking into account progress in terms of the popularization and standardization of such products and services, such efforts should not necessarily be made by one company alone. In addition, given that government efforts need to be made from the perspective of the social system as a whole, it is necessary to consider developing a framework of collaboration among industrial, governmental, and academic actors that includes neutral, independent academic societies such as universities and research institutions.

Taking the matters mentioned above into account, in FY2016, we started and have been developing since, a review system consisting of experts from a variety of fields such as engineering and social studies and conducting surveys on social and industrial analyses of automated driving through the first phase of SIP-adus, with the objective of assessing the social impact of automated driving objectively in order to improve social acceptance.

In addition, the first phase of SIP-adus has held dialog sessions directly with students and other citizens. Symposiums have also been held since FY2016 as part of a program of collaboration with the Ministry of Economy, Trade and Industry and MLIT. These initiatives will continue to be undertaken. In anticipation of the social implementation of automated driving, we will strengthen initiatives to cultivate the social acceptance of automated driving in the second phase of SIP-adus.

Development of collaboration systems by a variety of entities, including regions

In order to promote innovation in the midst of heightened interest in ITS/automated driving, it is essential to build places where a variety of industries and entities exchange information and create new efforts based on the needs of the field, and raise the level of the entire society, including regions, small and medium-sized enterprises, and venture companies.

Thus, places (such as regional councils and forums) shall be developed where not only the automobile and electronic industries, but also a range of industries including IT and finance, as well as SMEs, venture companies, universities, research institutions related to automated driving, NPOs and other public bodies, and also regions with interests and needs, can exchange opinions on the matter across sectors.

Through these systems and based on the specific mobility needs in each region, efforts shall be made to develop a mechanism that enables specific efforts toward the resolution of regional issues via ITS/automated driving, including the use of microcars, through collaboration between local public organizations and local small to medium-sized and venture companies and contribute to regional revitalization as a result.

F. Field operational testing

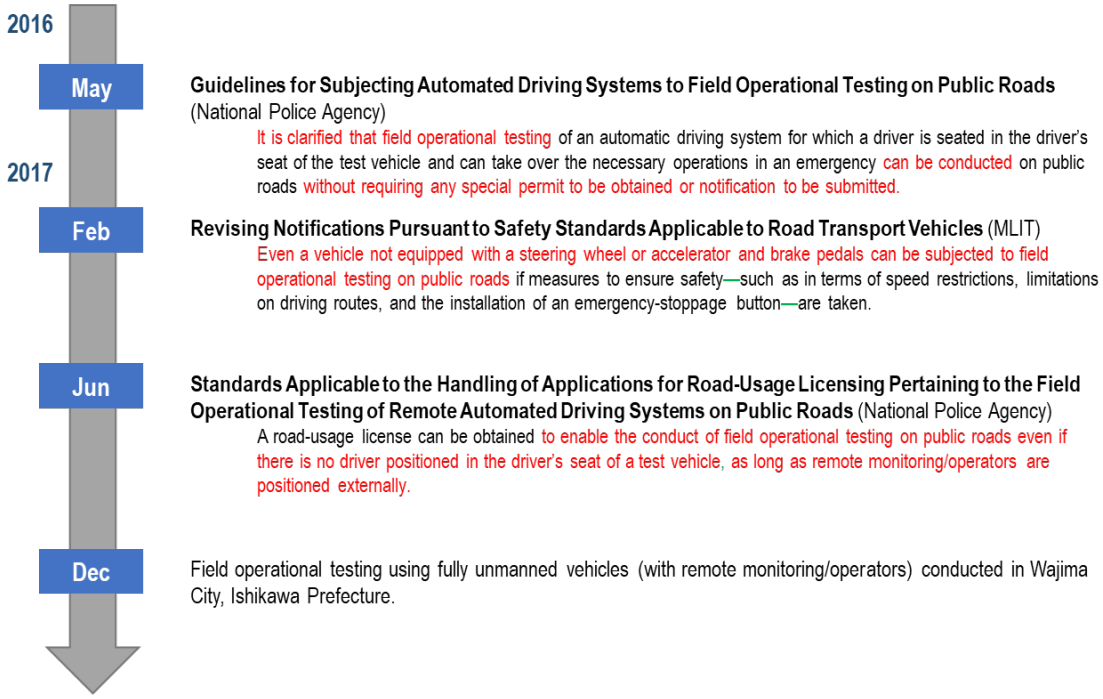
<Improvement of legal system pertaining to field operational testing of automated driving on public roads>

Environments of field operational tests on public roads and actual operation of automated driving systems in Japan are being developed based on international discussions on the relationship between automated driving systems and Convention on Road Traffic. Specifically, field operational tests on public roads can be conducted regardless of levels of driving automation without requiring special

permissions or applications, if the vehicle operates in compliance with related laws and regulations including the Road Traffic Act, with a driver in the driver's seat and by ensuring that emergency situations can be handled. As of June 2017, Japan has developed a system to enable the implementation of testing to be conducted on public roads, of remotely controllable automated driving systems that have been confirmed to be consistent with Convention on Road Traffic. Thus, the institutional environment pertaining to field operational test in Japan is superior to other countries around the world.

In addition, with an eye to promoting various types of innovation, related public notices were revised in February 2017 based on the Road Transport Vehicle Act so that safety regulations for road vehicles will be relaxed on vehicles with no steering wheel or accelerator pedal, and field operational tests on public roads are continuously promoted.

Figure 18: Developing safety regulations and traffic rules for field operational testing



As a result of improvement of legal system for the purpose of implementing driverless automated driving transport services in specified areas, field operational testing on public roads has become possible. In April 2017, mock urban area test courses were opened. Preliminary test services for evaluating safety measures through the use of these test courses were launched in February 2018. In addition, many field operational tests on public roads, including those conducted for projects led by the national government, have been carried out. We will continue to utilize these institutions and facilities and proactively promote field operational testing on public roads in Japan.

Furthermore, we are undertaking the creation of a system to facilitate the rapid and smooth realization of field operational testing of advanced innovative near-future technologies for automated driving as a regionally-limited regulatory sandbox program in National Strategic Special Zones and having zone plans that have been drafted by the national government, local public organizations, and businesses working in tandem (sandbox-implementation plans) become subject to special regulatory measures where approval has been granted by the Prime Minister.

Moreover, "Automated Driving One-Stop Centers" for providing advice and information to private-sector businesses conducting field operational testing were established in Tokyo and Aichi Prefectures in 2017 and Kita-Kyushu and Fukuoka in 2018. Efforts to promote the further utilization of these centers will be taken in the future.

Development of the public-private cooperation system and sharing of data related to field operational tests

In order to accelerate the early realization and social implementation of automated driving-based transport services, we have been sharing the data obtained through field operational testing on public roads with concerned parties since 2017. Therefore, we have been building a database to share the obtained data with concerned parties to be able to apply it to the next field operational tests and use it to study commercialization. Data sharing is not only useful for securing social acceptance but also important for considerations with regard to future R&D and institutional approach.

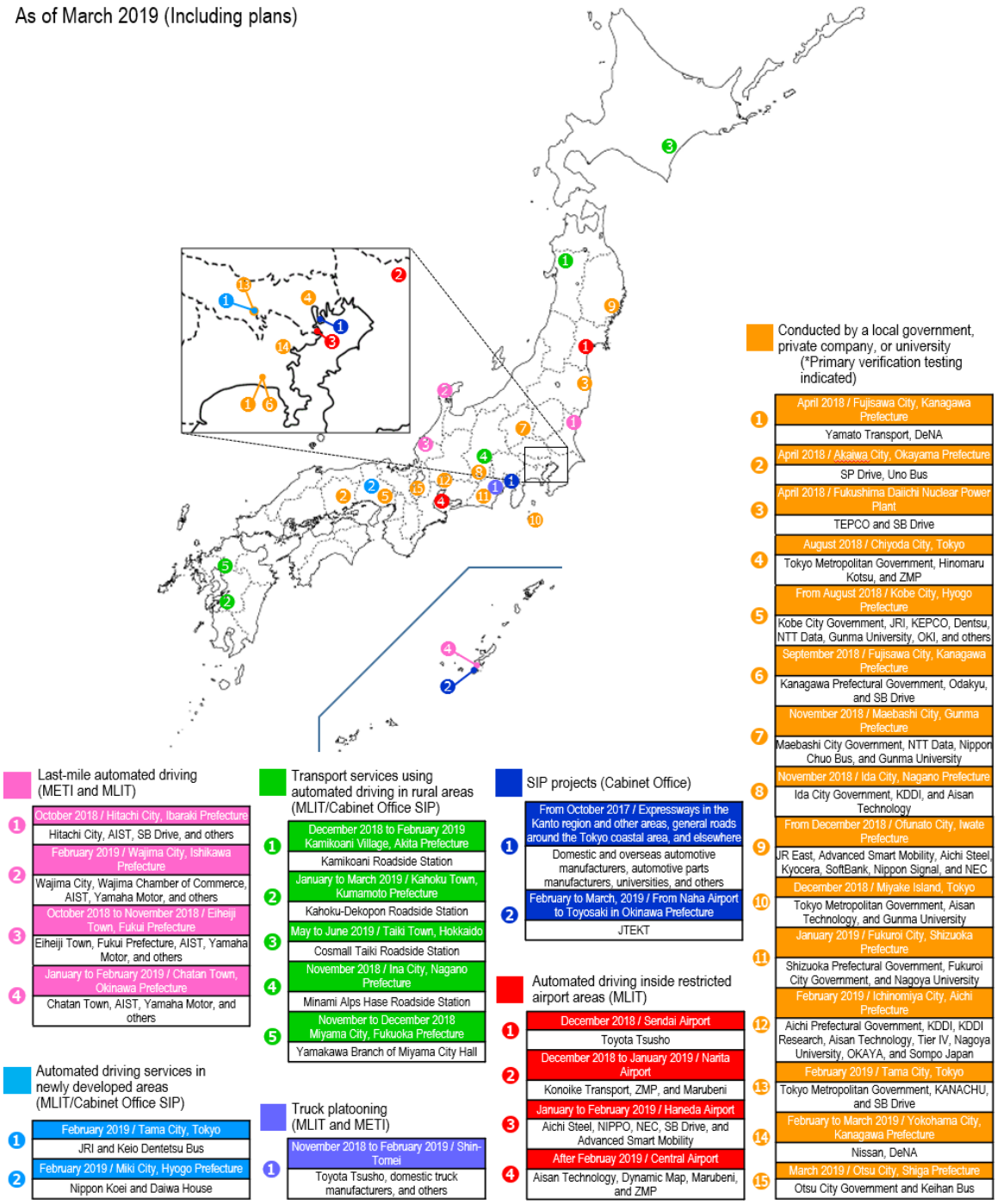
During the data collection process, the data obtained through field operational testing on public roads is divided into three formats and shared. We are making efforts to share the driving route that the public road field operational testing is predicated on, the distance and weather, time and vehicle specification, communication system, and other "driving environment data" as well as the driver operations and other "difficult situation data" information which facilitates the improvement of safety including examples of responding to difficult situations, and we also provide passenger and local resident attributes (age, gender, etc.), tabulated questionnaire results (convenience assessment, needs, etc.), local characteristics (population scale, etc.), and cost-effectiveness "feasibility data."

In order to examine the tasks to set for the next round of field operational testing such as price setting, different environments, and testing in environments with a greater number of traffic entities, we are analyzing and using the information, storing the data obtained through field operational testing on public roads in FY2018 and FY2019, and we will reevaluate the data items which should be shared as needed.

<Field operational testing on automated driving as conducted by public-sector or private-sector actors in Japan>

As noted above, field operational testing on automated driving is being or is slated to be conducted throughout Japan after safety regulations and traffic rules that were applied to field operational testing conducted are updated.

Figure 19: Primary automated driving field operational tests conducted in Japan (since FY2018)



<Primary items subject to verification in field operational tests>

Primary items subject to government-led automated driving field operational testing that has been or is slated to be held are indicated below.

Table 10: Classifying field operational tests by purpose

Purpose	Verification items	Corresponding field operational testing
Verify vehicle performance	• Verifying the safety and reliability of remote monitoring (such as by checking compliance with safety regulations and verifying that safety is ensured for measures that entail the relaxing a part of the safety regulations); and more	• Last-mile automated driving 1 - 4 • Truck platooning 1 • Automated driving in restricted airport zones 1 - 4
Verify the impact of weather conditions on vehicle performance	• Verifying the detection function of sensors under conditions of rainfall, snowfall, snow accumulation, and thick fog • Verifying the ability to drive during snow fall, etc.	• Last-mile automated driving 1 - 4 • Truck platooning 1 • Transport services based on automated driving in regional areas 1 - 5
Verify issues concerning technologies comprising automated driving	• Testing high-precision 3D maps • Testing HMI in terms of driver condition assessments, etc. • Testing of technologies which provide signaling information • Testing of merging assistance information to go from ordinary roads to expressways, etc.	• Last-mile automated driving 1 - 4 • Truck platooning 1 • SIP projects, etc. 1, 2
Verifying the configuration, maintenance, and management of roads and surrounding facilities	• Verifying road structure conditions and road management levels • Verifying communication systems for remote monitoring, etc.	• Last-mile automated driving 1 - 4 • Truck platooning 1 • Transport services based on automated driving in regional areas 1 - 5 • SIP projects, etc. 1, 2 • Automated driving in restricted airport zones 1 - 4
Verifying service contents	• Shipping tests using vehicles consolidated freight and passenger between local sites such as roadside stations and communities • Creating new tourist movement flows; and more	• Last-mile automated driving 1 - 4 • Transport services based on automated driving in regional areas 1 - 5 • Automated driving services in new housing developments 1, 2 • SIP projects, etc. 1, 2
Verifying service operations	• Verifying the costs of maintaining and managing vehicles • Investigating operator models, etc.	• Last-mile automated driving 1 - 4 • Truck platooning 1 • Transport services based on automated driving in regional areas 1 - 5 • Automated driving services in new housing developments 1, 2 • SIP projects, etc. 1, 2 • Automated driving in restricted airport zones 1 - 4

Verifying social acceptance	• Reliability of automated driving technologies, riding comfort, psychological response to a driverless state • Survey of social acceptance to public buses using automated driving technologies and last-mile mobility options; and more	• Last-mile automated driving 1 - 4 • Truck platooning 1 • Transport services based on automated driving in regional areas 1 - 5 • Automated driving services in new housing developments 1, 2 • SIP projects, etc. 1, 2 • Automated driving in restricted airport zones 1 - 4

<Field operational testing with eyes focused on the 2020 Tokyo Olympic and Paralympic Games>

Based on the Prime Minister's statements[36] at the Council on Investments for the Future, the Cabinet Office SIP is coordinating with the relevant agencies and ministries, preparing the driving environment including the road transport infrastructure, etc. needed for early-stage automated driving, receiving cooperation from the Japan Automobile Manufacturers Association, Inc. (JAMA), and will conduct field operational testing in the Tokyo waterfront area from the fall of 2019 with participation from foreign and domestic automobile companies, suppliers, and universities, etc. In 2020, JAMA will use this road transport infrastructure to conduct a demonstration, which will lead to commercialization. Moreover, popularization measures will be studied while also continuing field operational testing and research and development work in anticipation of obsolescence after the Olympic/Paralympic Games to improve the international dissemination and social acceptance of Japan's automated driving solutions.

<Other kinds of field operational testing>

In addition to the above, various kinds of field operational testing are slated in hopes of resolving new societal issues. Examples are presented below.

36 At the 14th Council on Investments for the Future on March 30, 2018, the Prime Minister stated, "We will realize an automated driving society in Japan for the 2020 Tokyo Olympic and Paralympic Games. The field operational tests carried out by the public and private sector toward this significant goal have finally reached the business stage. We will further accelerate our efforts with a view to deploying a wide range of businesses."

Table 11: Other primary kinds of field operational testing

Field operational testing	Conducted by	Outline
Upgrading snow-removal vehicles with a focus on automated driving	MLIT	The development of snow-removal vehicles upgraded with driving-control and operating-support functions for power-saving benefits is being promoted in stages, trial runs on expressways are scheduled to start in February 2018 with field operational testing on ordinary roads in March 2019.
Investigating measures for the utilization of automated driving technologies for urban traffic	MLIT	· Field operational testing will be conducted beginning in FY2018 based on reports of the effectiveness and issues through the adoption of automated driving services with a view to realizing sustainable public transit services in areas with new housing developments. · Plans are in the works to prepare for field operational testing on guideway buses, route-defined excursion-type buses, and other core bus service vehicles and provide for the means by which information can be shared.

Field operational testing in the future will need to be promoted by determining what sorts of solutions will be needed after further clarifying issues standing in the way of commercialization based on the results of evaluations of vehicle performance, evaluations of the impact of weather conditions (such as snow accumulation) on vehicle performance, evaluations of issues concerning technologies comprising automated driving systems, evaluations of the configuration, maintenance, and management of roads and surrounding facilities, evaluations of the operations of services, and evaluations of social acceptance as verified to date. In addition, we will need to further accelerate efforts with a view to deploying a wide range of businesses ahead of 2020.

(4) Promotion of international regulations and international standards

Strategic efforts toward the development of international regulations and standards

In order for Japan's automobile industry to lead the world and actively contribute to resolving social issues including the reduction of traffic accidents, it is important to build a system that strategically responds to the efforts to develop international rules (regulations and standards) that will serve as a foundation for the promotion of efforts in the cooperative area.

Regarding the examination of international regulations pertaining to automated driving, we are serving as co-chairs and vice-chairs in the Working Party on Automated/Autonomous and Connected Vehicles (GRVA) and the expert meetings set up underneath GRVA for studying technical regulations concerning automated steering, expert meetings on Advanced Emergency Braking Systems (AEBS) for passenger cars, the cyber security task force, and the automated driving certification expert meetings within the UNECE World Forum for Harmonization of Vehicle

Regulations (WP.29). Given the existence of plans to discuss various issues, including those pertaining to manned automated driving systems at Level 3 and above, international discussions in the field of automated driving will continue to be promoted under the purview of WP29.

For the efforts for the establishment of international standards for automated driving, Jap an is in position to lead[37] the discussion as some of the important TCs (Technical Commit tees) are headed by Japanese chairpersons. Moreover, since the relationship between ISO/T C 204 (ITS) and TC22 (vehicles) has become more complicated, an automated driving stan dardization study panel was established in the Society of Automotive Engineers of Japan, I nc., a domestic deliberative body in this field, to promote cross-sector information sharing and examine strategies. On the other hand, along with growing interest in automated drivin g, the number of international standardization items has significantly increased in recent yea rs. In order to respond to this trend, it is necessary to continue examining measures to stre ngthen mechanisms to secure resources such as experts involved in the implementation of s tandardization activities. Important subjects for standardization include communications, ergo nomics, functional safety, security, and recognition technologies.

Moreover, in order to lead the world in the field of rule-based automated driving, it is essential to have international strategies that fully cover regulations and standards. Therefore, Institute for Automated and Connected Vehicle Standardization, Japan[38] was established in May 2016 as a place for strategic discussions to bridge the gap between regulations and standards. Japan continues developing strategies that allow it to lead international activities in accordance with its future vision of automated driving.

The UN is discussing the development of international regulations related to Minimal Risk Maneuver (MRM), which are not only essential for automated driving but also indispensable for "sophisticated driving safety support systems (tentative name)," and Japan will continue playing a leading role in such discussions.

In addition, it is essential to utilize radio waves and secure the safety of information and communication networks in order to achieve/upgrade automated driving and connected cars. International Telecommunication Union (ITU)[39] has agreed to include "global or regional

37 In TC22, Japan serves as the chair and secretariat for SC32 (Electrical & Electronic components and general system aspects), where issues such as information security and functional safety are handled. In TC204, a Japanese member was elected as a convener (equivalent to a chairperson) for WG3 (ITS Database technology), where map information is handled, and in WG14 (Vehicle/Roadway warning and control systems), where automobile driving control is addressed.

38 The Institute was established within the Japan Automobile Standards Internationalization Center (JASIC). The director of the National Traffic Safety and Environment Laboratory, National Agency for Automobile and Land Transport Technology, serves as director of the Institute.

39 International Telecommunication Union (ITU) is an international organization that determines frequency allocation and develops international standards and recommendations related to communications. ITU Radiocommunication Sector (ITU-R) has agreed to include "global or regional harmonization of frequency bands for ITS" as an agenda item for the 2019 World Radiocommunication Conference (WRC-19).

harmonization of frequency bands for ITS” as an agenda item for the 2019 World Radiocommunication Conference. Japan shall play a leading role in that discussion toward the global harmonization of frequency bands for ITS including automated driving.

<Promotion of international collaboration and exercise of leadership>

In order to build the world's most advanced ITS, including the development and popularization of automated driving systems in the future, it is necessary to promote initiatives and collaboration from a global perspective without limiting them to activities within the country and display international leadership.

To this end, it is important for Japan to actively participate in existing international frameworks and activities in Europe and the Americas; promote the exchange of information on international standards including terms related to automated driving systems, functions, component technologies, performance regulations, and conformity assessment and joint research on human factors and social acceptance from a global perspective; and play a leading role in building global consensus through these activities. Therefore, as part of the efforts to display international leadership, the first phase of SIP-adus holds an international conference on automated driving every year in Japan. During the second phase of SIP-adus as well, we aim to display international leadership with the goal of introducing internationally harmonized automated driving technologies.

In addition, as interest in automated driving has been growing around the world in recent years and a high level of international collaboration has been promoted, Japan shall actively respond to this trend. Specifically, the G7 Transport Ministers’ Meeting was held in Italy (Cagliari) in June 2017. It was agreed then that the members would incorporate into their declaration both a desire to cooperate at an international level, as set forth in the UN’s WP29, and the exchange of information with respect to best practices, research activities, and data concerning automated driving among working groups dealing with automated driving, with a view to commercializing higher level (Level 3 and Level 4) automated driving technologies under manned conditions. A Working Group was hosted for policymakers in Canada (Ottawa and Montreal) in June and October of last year and again in France (Paris) this past April to share information about common issues (social acceptance, safety verification, field operational testing, and responsibilities, etc.) and automated driving policies in each country. Going forward, the G7 countries will continue to collaborate based on the results of the Ministers’ Meeting and the Working Group. In addition, as part of its efforts for bilateral

cooperation, Japan has issued a high-level Joint Declaration[40] of Intent related to automated driving with Germany. Japan shall make efforts based on this statement and consider cooperating with other countries and regions from a strategic perspective on an as-needed basis.

40 In January 2017, the Minister of State for Science and Technology Policy Yosuke Tsuruho signed the "Joint Declaration on Intent for Japanese-German Cooperation on the Promotion of Research and Development on Automated Driving Technologies" with the German Federal Minister of Education and Research. The Declaration states that both countries should work together to promote R&D of automated driving technologies.
In March 2017, the Minister of Economy, Trade and Industry Hiroshige Seko and the Minister of Internal Affairs and Communications Sanae Takaichi signed "Joint Statement on Cooperation between the Ministry of Economy, Trade and Industry of Japan and the Federal Ministry for Economic Affairs and Energy of the Federal Republic of Germany regarding the Internet of Things (IoT) / Industrie 4.0" (Hannover Declaration) with the Federal Minister of Economic Affairs and Energy of Germany. The Statement states that both countries will discuss policies on the issues related to the automobile industry including automated driving and connected cars.

3 MaaS and other new mobility services

(1) Overseas initiatives for new mobility services

A. Popularization and expansion of new mobility services

As the waves of the Fourth Industrial Revolution reach the world of mobility, new services using IoT and AI continue to spread. Services such as MaaS which integrate multiple transportation modalities to enable central unified search/reservation/payment, demand transportation services that flexibly change the transportation route according to demand, as well as car sharing and ridesharing services that reflect the sharing economy trend are expanding around the world.

Figure 20: Types of mobility services[41]

Service category				Service details
Car sharing	B2C		Roundtrip	Car-sharing service assuming return to the station where the car was borrowed In recent years, reservations, receipt, and return procedures can be completed using smartphone apps
		One-way	Station-based	Car-sharing service under which the vehicle may be left at another location
			Free-floating	Car-sharing service under which the vehicle may be left freely on public streets, in public parking facilities, or elsewhere within a predetermined area
	C2C			Car-sharing service under which users may lend and borrow privately owned vehicles to and from each other
On-demand transportation	Fixed-route			Shared bus service that operates only by reservation, based on ordinary bus routes
	Semi-flexible route-based (micro-transit)			Shared bus service that operates on routes and schedules updated frequently according to user demand
	Free-route	B2C	Taxi dispatching	Service providing high-efficiency taxi dispatching using dispatching apps and other means
			Shared ride taxi	Service enabling efficient transportation of people heading in the same direction by matching them using dispatching apps and other means
		C2C	Ride-hailing	Service in which ordinary drivers transport passengers in private vehicles
			Carpooling	Service matching people heading in the same direction
Logistics	Multimodal service			Service realizing centralized searching, reservations, and settlement combining multiple transportation modes (rail, bus, taxi, car-sharing, etc.) using an app
	P2P logistics matching			Service matching shippers with logistics providers
	Consolidated freight and passenger			Mixed transportation services for people and cargo, through freight transportation by passenger carriers and passenger transportation by freight carriers
	Last-mile delivery automation			Delivery service using unmanned delivery vehicles, including drones, for the last mile of delivery
	Parking-space sharing			Service enabling temporary lending or borrowing of monthly or private parking spaces using apps and other means
Linkage of mobility services and peripheral services				Service encouraging consumption using food-delivery services, advertising, distribution of coupons, and other means in utilization of existing mobility-service infrastructure
Connected car service				Service realizing advances in maintenance, business operation, etc. through connecting vehicles

<B2C car sharing>

In North America and Europe, free-floating B2C car sharing services, which differ from the station-based services that are common in Japan, are being deployed which allow users to freely leave the vehicle on the road, in a public parking lot, or another location which is not where the car was borrowed as long as it is within a fixed area. These services are very beneficial in that users do not have to pay a fee while parking at the destination and can spend less time searching for an open

41 "Interim Working Group Summary Concerning New Mobility Services Enabled by IoT and AI" (2018/10/17, METI)

parking space. As a result of this high degree of convenience, the number of users is rapidly increasing in North America and Europe.

<C2C car sharing>

C2C car sharing is a service which provides features for individuals who own a private vehicle to rent out their vehicle to a different person, and a significant number of venture companies aiming to create platforms for such services have appeared all over the world. The services are becoming more sophisticated in the ways that they use data such as recommending vehicles which meet the needs of borrowers based on their usage history and implementing features for recommending priority price settings, based on price setting trends for the same model vehicle, to users that are renting out private vehicles.

<Semi-flexible route-based demand transportation (micro transit)>

Micro transit is a passenger bus service which operates while frequently updating the route according to user demand. Because such services are able to configure the route in a manner which is more flexible than conventional route buses by linking the operation information with the travel demand information through smartphones, they provide a balance between user convenience and improved transportation efficiency for operators. Moreover, because the micro transit services use vehicles with a greater transportation capacity than the passenger-sized vehicles primarily used by the flexible route-based demand transportation described below, they also have the advantage of being able to keep the user fees relatively low.

<Flexible route based demand transportation>

Flexible route based demand transportation is the name for mobility services which dispatch an automobile with a flexible route and time according to user demand. This category applies to taxi dispatch services which match a taxi driver with an individual user, ridesharing taxis which match users traveling in the same direction to efficiently transport them together, and other services using an app. Other examples include ride hailing in which a general driver uses a private vehicle to transport an individual passenger and carpooling types of services which match people traveling in the same direction to transport them together. Platform-based companies that comprehensively provide these various services have appeared in every country, and their presence is growing stronger.

<P2P logistics matching>

Movements to create new mobility services which transport not only people but also items are appearing. For example, P2P logistics matching services efficiently match shippers with delivery personnel through platforms. Using technology which monitors the distribution of vehicles and cargo

in real time as a foundation, these services know which delivery vehicles are empty and the location of nearby package shippers who are waiting for a pickup, and they are able to efficiently match them to appropriately balance supply and demand to improve the efficiency of item shipping.

These types of new services not only improve convenience for consumers, but they also improve transport efficiency, reduce operating costs, create new business models, and provide other advantages to companies. On the other hand, the rapid growth in demand car services has led to a sudden increase in traffic volume in urban areas, which has been identified as a problem due to the fact that the services promote traffic congestion and air pollution as a result and require further monitoring. In fact, the number of app-based dispatch vehicles operating in New York City increased from 12,600 vehicles in 2015 to 80,000 in 2018, and the city has issued an ordinance restricting the issuance of new licenses for dispatch service vehicles.

B. MaaS initiatives to solve problems at the national and city level

As mentioned above, while the ill effects due to advancement on the level of individual modalities and the increasing popularization are being identified, movements are surfacing which aim to solve problems of urban transportation policy, including clearing up congestion and measures for those with poor mobility, by performing an overall optimization of a diverse set of mobility services on the state and city level, and the service systems which embody these aims fall under the concept known as MaaS.

MaaS not only resolves the inconvenience and inefficiency of transportation systems segmented by each transportation mode but also possesses the potential to transform user behavior through new rate structures. In addition, MaaS is also expected to expand the movement of not only people but also distribution.

For example, applying dynamic pricing[42] to the rate structure and setting the price of a transportation mode where demand is concentrated relatively high can be expected to promote the use of other transportation modes which are seeing low use and help optimize transportation supply and demand.

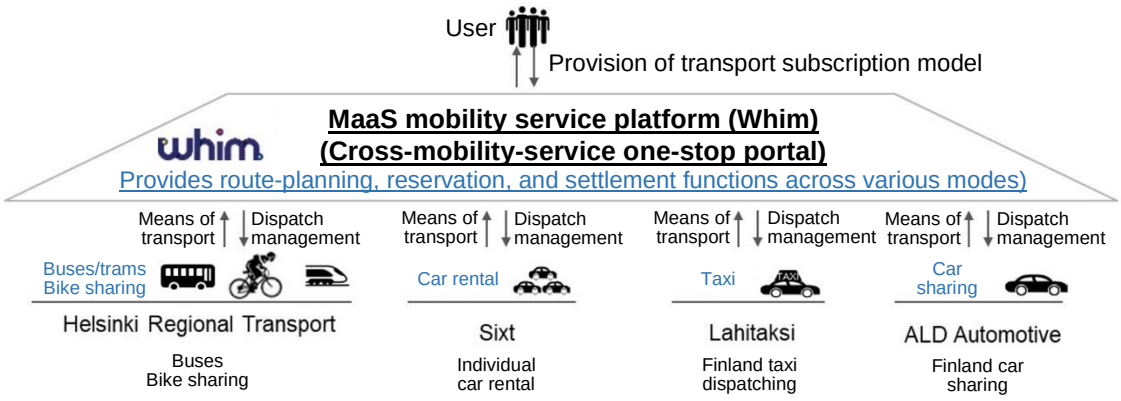
Table 12: Initiatives to expand MaaS...MaaS Global, examples of government initiatives

MaaS Global is a representative example from Finland of a company engaged in providing MaaS. The Ministry of Transport and Communications (LVM) in Finland is focusing its efforts on initiatives to create new industries through the application of ICT. As part of those efforts, MaaS is positioned as a priority area, and the concept is being promoted as a national agenda.

42 Dynamic pricing is a method of adjusting demand by changing the price according to the supply and demand situation

Behind the scenes of this initiative, MaaS Global received assistance from LVM and the National Technology Agency (TAKES) in establishing MaaS Global. A MaaS app called "Whim" unifies features for route searching, reservations, and payment for buses, trams, bike shares, rental cars, taxis, car shares, and various other forms of transportation, and it is unique in that it provides a subscription-based[43] rate structure. The app aims to shift movement from private vehicles to public transportation by increasing the convenience of public transportation to a level which is equal to or greater than private vehicles. The data linking between transportation business operators that is necessary to provide services is being pushed forward by the government through the enactment of laws which require transportation business operators to openly release their APIs. In fact, when looking only at Whim users, the use of public transportation has increased from 48% to 74% compared to before, the use of private vehicles has decreased from 41% to 20%, and they are seeing a shift from private vehicles to public transportation.

Figure 21: MaaS Global business model[44]



Furthermore, government-backed initiatives to promote MaaS are being seen around the world. For example, the city of Los Angeles in the United States, which has a low rate of public transportation use and severe traffic congestion, is deploying the GoLA[45] one-stop portal which enables the use of various means of transportation. Resolving the inconvenience and inefficiency of traffic systems which are segmented by transportation mode promotes the use of public transportation with the goal of escaping from transportation systems with an excessive dependency on private vehicles as demonstrated by the trend towards active initiatives by local public organizations.

43 Instead of owning products and services, subscription-based users obtain the right to use products and services and pay a fee according to use

44 MaaS Global official web site

45 GoLA was released with the cooperation of companies in the city of Los Angeles and is a one-stop portal which enables the use of various means of transportation including public transportation, shuttle buses, ride sharing, car sharing, and bike sharing, etc.

(2) Initiatives for new mobility services in Japan

In Japan as well, taxi dispatch, demand-based passenger buses, and other new mobility services which use AI and IoT are actively being deployed, and they possess significant potential to improve convenience for users, solve transportation problems in regional cities, solve problems of poor mobility among the elderly drivers, and revitalize regions.

i. Creation and advancement of new mobility services

Taxi dispatching apps, a popular initiative in Japan in recent years, are services which match users with taxi drivers through an app. Compared to conventional telephone-based taxi dispatch, they are highly convenient for users from the standpoint of being able to easily and quickly dispatch a taxi which is currently nearby. Moreover, taxi operators can anticipate the advantages of their introduction. For example, by predicting the demand for taxis from the past app user history, etc. using AI and introducing a system that guides the driver along the route, it enables even young and inexperienced drivers to optimally dispatch taxis according to demand, which leads to an increase in revenue. Moreover, correcting for the differences in income due to differences in experience keeps the younger generation from quitting and can be expected to solve the driver shortage problem.

Furthermore, the advancement and expansion of the use of micro transit possesses the potential to solve the public transportation problems currently faced by operators, users, and society. For example, in regions where it is difficult to maintain a transportation network due to financial factors, micro transit can be expected to reduce the operating costs of companies by using AI technologies to automatically dispatch vehicles and set routes according to demand and match passenger vehicle users, etc. From the standpoint of users, it will lead to securing door to door means of transportation at a comparatively low price for elderly citizens and others with poor mobility options, and the activation of transportation can be expected to also have the effect of revitalizing the regional economic society.

ii. Creating the data collaboration platform

In addition, initiatives to implement MaaS to provide route searching, reservations, and payment features for various means of transportation in a one-stop format are also gaining momentum in Japan. Currently, various companies are proceeding with field operational tests in various areas including cities, suburbs, and tourist attractions, but from the perspective of the users, a "universal MaaS" which mutually interconnects the MaaS systems needs to be built.

For example, initiatives to digitize information and build infrastructure to link data between operators is gaining momentum due to the creation and release of a bus information format which is compliant with GTFS[46] in the bus industry, and currently 90 bus companies and municipalities across the country have achieved the digitization and open availability of static information for timetables, etc. Implementing a universal MaaS in the future requires the digitization of various types of data and the construction of a digital linking infrastructure to link real-time operation information, reservation status, and other dynamic information not only between companies in the same industry but also between the MaaS system and transportation business operators.

In addition, MaaS is also expected to expand the movement of not only people but also distribution going forward.

iii. Linking with the non-mobility areas

In this way, MaaS and other new mobility services are gradually developing in Japan as well, but they can be expected to lead to further economic and regional revitalization by linking to various non-mobility areas such as tourism, dining, real estate, etc. in the future. For example, you could flexibly link tourism spots to promote excursion behavior within the area through transportation for the purpose of tourism and highly compatible micro transit, stimulate consumption through ad delivery for coupons, dining and tourism related facilities, etc. through a MaaS app, or you could conceivably increase real estate value by repurposing parking spaces at property which comes with the right to use mobility services. Other possibilities include, in particular, the potential to improve the mobility of those with poor options and help reduce social costs by advancing the use of mobility in the medical and nursing fields. The social expectations for linking with non-mobility areas are huge.

iv. Utilizing automated driving

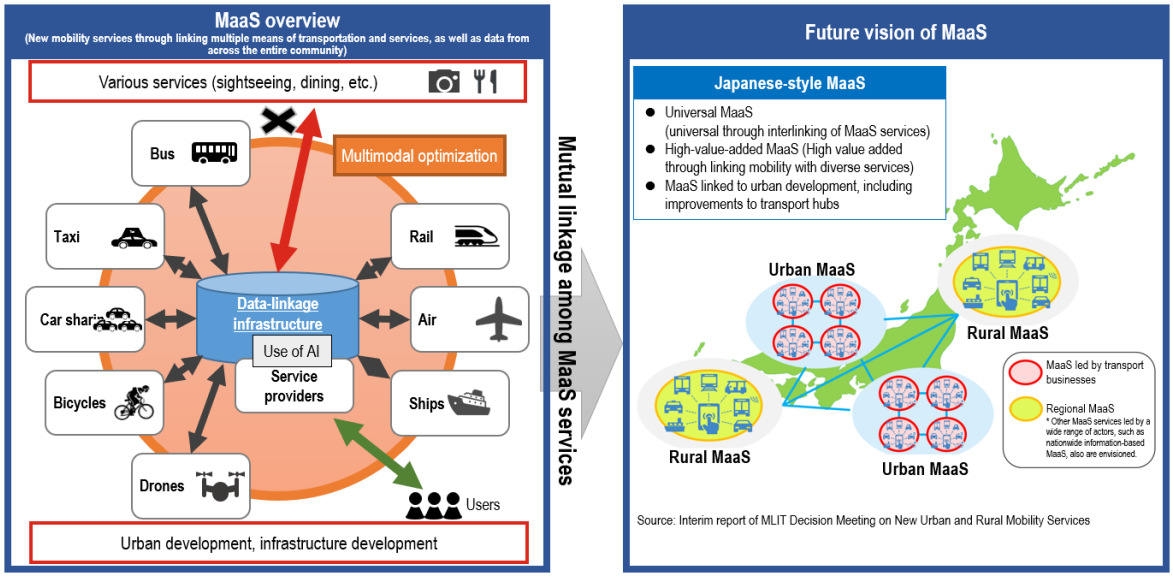
Moreover, if the fusion of automated driving technologies advances in the future, the current state of mobility is expected to significantly transform. For example, in addition to providing a higher level of convenience, the verification projects of new mobility services using robot taxis, robot shuttles, robot delivery, etc. that are being conducted in Japan are confirming the potential to help solve the social issues faced in Japan including driver shortages, the feasibility of public transportation, the issue of poor mobility in regional depopulated areas, and the challenges faced by distribution due to the rapidly increasing demand from the expansion of e-commerce, etc.

46 GTFS defines a common format used for public transportation timetables and their geographic information. It was initially created for Google, but currently it is open source and can be used by anyone. It is widely used overseas mostly in North America and Europe.

In this way, MaaS initiatives which solve various social issues are starting by seamlessly linking multiple transportation and non-mobility area services through a data collaboration platform while also advancing mobility services including the implementation of automated driving technologies.

Going forward, in addition to making efforts to optimize the entire region according to needs within the flow of all movement including people and distribution, we aim to realize a MaaS of the future in which all regions and all people can use new mobility services through universal support via mutual MaaS linking, creation of high added value through linking transportation with diverse services, transport hubs between various transportation modes, infrastructure provision to secure driving spaces which support new mobility services, and linking with community development.

Figure 22: Future vision of MaaS[47]



(3) Direction of issues and initiatives

In this way, initiatives for MaaS and other new mobility services are also starting in Japan, but the full-fledged social implementation is still getting underway. Currently, on the business side there are issues with the infrastructure provision for data linking and expansion of data use as well as collaboration with non-mobility services, while on the institutional side, there are issues with the application, etc. of laws and regulations with respect to new services.

In addition, in order to truly link such new mobility service initiatives to solutions for regional social issues, we need to promote the linking of companies etc. and regional movements to take on the challenge of new initiatives according to mobility needs by region and issues.

47 Second Road Transport Working Group (2019/2/15,Cabinet Secretariat IT Strategic Office)

A. Infrastructure development for data linking and the expansion of data use

<Promoting the digitization of mobility related data>

The use of digital technologies is a necessary condition to achieve seamless means of transportation which span different transportation business operators. However, in the case of buses, for example, there are many cases where even static data such as timetables and fares, etc. is not digitized especially at small to medium-sized companies. Under the current circumstances, service companies which provide transfer information digitize and collect the data managed by each bus company in an analog manner. Therefore, we first need to promote digitization through improved support in transportation business operators where static and dynamic information have not been digitized so that data management using the nationally-recommended data format advances. Next, we need to promote the modification of systems to support the nationally-recommended format for transportation business operator data that has already been digitized and loaded into a system.

<Standardize and make data and APIs openly available>

There are many companies that wish to close their data off for use within their own services, because data maintenance, processing, and analysis requires fixed costs within companies, and they view their own data as a source of differentiation. Therefore, it will not be easy to build a cooperative framework for integrating APIs and making data openly available. The companies need to be motivated by clarifying the social significance, purpose, and benefits to the providers by explaining that API integration and data open sourcing will contribute to the future advancement of MaaS, help solve congestion through traffic flow optimization on a social level, and aid in streamlining the facilities owned based on peak demand and the associated maintenance costs on a company level, etc. At that time, it is thought that it will be important to stratify and examine the data which must be linked to realize MaaS, draw a line between the data which should be open sourced (cooperative areas) and other data (competitive areas), and clarify that participation is predicated on data sharing which is limited to the cooperative areas.

In addition, the construction of infrastructure for the smooth integration of data and APIs is also a necessary element. In the event that the data formats and API specifications are different for each transportation business operator, the time and cost required to convert/process each data set to the same format and build systems for multiple API specifications cannot be ignored by MaaS operators (players providing MaaS), and service users may lose benefits as a result. Therefore, we need to create a nationally-recommended format and guidelines, etc. to develop a fixed set of rules while also building the appropriate data format and API integration/standardization system so that data can be linked as smoothly and inexpensively as possible.

<Building a data platform>

Moreover, when promoting MaaS, we should build a data platform which covers the necessary information as early as possible so that MaaS operators can easily understand what types of data can be obtained. In this case, we should clearly state the usage fees, scope of use, and other data transfer conditions for data in competitive areas as well to aim for system which can be used on top of the data platform. In addition, in order for MaaS to create new transportation demand and high value-added transportation, it would be advisable to build a data platform which takes into consideration retail, dining, lodging, tourism, and other industry services as well as mutual linking between MaaS platforms, and a response is required based on the premise that clarification of the MaaS mutual interlinking policies is aimed at realizing a MaaS universal service.

<Fair and fee flexibility, cashless payment>

In order for MaaS to maximally increase user convenience, it would be advisable to provide transportation from the point of departure to the destination as one service in an app, etc. and provide fares and fees that are priced based on user needs as MaaS eventually becomes more sophisticated. On the other hand, an upper limit needs to be set on the fees from the perspective of protecting users based on the characteristics of each transportation mode while also guaranteeing a system which is similar to the current rate and fee system which does not allow dumping to occur so that companies can ensure safety and properly operate.

First, as a precondition, the fares for each means of transportation must be confirmed ahead of time in order to combine multiple means of transportation in advance to provide search, reservations, and payment in MaaS, and an advance fair confirmation system, which can calculate fares based on the reservation time and the expected route at the time of dispatch, must be immediately introduced. In addition, the promotion of cashless payment is important for the smooth deployment of MaaS. Currently, there are some transportation business operators that have not implemented cashless payment using transportation IC cards, which are the primary method of payment. These companies need to build new payment systems which support cashless payment and ways of confirming payment when passengers board. However, installing data servers and devices on each vehicle, etc. may require a significant investment particularly for companies with money-losing routes, and figuring out ways to somehow reduce this burden to promote cashless payments is an issue.

Once this infrastructure is developed, new ideas will also be needed in the rate structure in order to promote the use of MaaS as an important feature. For example, dynamic pricing that changes the fares and rates according to transportation demand optimizes traffic flows by managing supply and demand through price setting and has the potential to ease crowding and increase profitability through operational efficiency or help decrease the user waiting time. Moreover, subscriptions (flat-rate services) ensure a certain level of income for companies while also removing user payment

hassles and concerns about added costs, and they can be expected to increase the volume of travel around public transportation by improving travel incentives to create prosperous towns as a result. However, it is expected that there will be various issues with the introduction of such a new rate structure.

For example, in dynamic pricing the rates change according to supply and demand. However, there are many issues from the perspective of protecting users such as the degree to which prices can be allowed to rise during times of excessive demand in areas with highly public transportation services or systems to ensure that users appropriately understand the fluctuating fares. On the other hand, it is expected that there will be issues with subscriptions concerning the establishment of rules for the distribution of fair income between multiple transportation business operators. So, while new and highly flexible rate structures will provide advantages to users and companies in this way, they should be introduced after a sufficient degree of investigation and verification, because it is expected that there will be issues as described above.

<Ensuring safety and protecting private information>

The construction of a data collaboration platform is premised on a reliable mechanism which does not impede the open sourcing of data and release of APIs by companies. In other words, measures are needed to protect private information such as limiting the usage to anonymously processed information, because there are concerns that individual privacy problems will become apparent depending on the data safety assurances which establish uniform security regulations, etc. and the scope of data linking. It is important to create rules through public and private sector partnerships which control risks for transportation business operators without creating disadvantages for users at the same time.

B. Promoting links to non-mobility services

The monetization of mobility services is thought to be limited based on only the price for providing the means of transportation, and it will be important to establish business models that can expect sustainable monetization through linking to other services. For example, it is believed that it will be important to effectively combine mobility services to expand the value provided by shopping, medicine, tourism, and other life services or as an effective solution to help increase their productivity. It is hoped that MaaS will play the role of a data platform in linking to services in various non-mobility areas such as searching for information about tourist sites and restaurants, making shopping and hospital reservations, etc. on the MaaS system to stimulate the promotion of links which span different industries in this way. Eventually a platform which uses MaaS as the starting point will be built to integrate citywide data across non-mobility areas, which can be expected to help realize the smart city of the future.

Going forward, the creation of new services which fuse mobility and non-mobility areas using various types of data must also be promoted on the nation level.

Moreover, as MaaS and other new mobility services spread and develop around the world going forward, we must ensure the competitiveness of Japanese industries by promoting the overseas expansion of services in newly created industrial domains in the future.

C. Issues on the institutional side

Regarding the commercialization of new mobility services, the vague positioning within the existing system acts as a constraint. Restrictions on the scope of services which can be implemented may occur as long as new service structures are applied with interpretations within the framework of the existing legal system which assumes essentially different industries. For example, in order to solve issues faced by transportation business operators such as management deterioration and a shortage of carriers as it is becoming difficult to ensure regional transportation due to population declines and the declining birth rate and aging population, we need to examine environmental improvements which make it easy to provide new services such as mechanisms which can engage in cross jurisdictional initiatives that transcend conventional municipal districts for onerous passenger transportation services with private vehicle which are currently only permitted in regions where it is difficult to ensure public transportation or the introduction of taxi ridesharing by developing rules, etc. which allow easy to use rate services to be provided through low cost ridesharing rates using vehicle dispatching apps and cashless payments.

Therefore, to prepare for the proper operation of MaaS, we should immediately examine the state of institutions including the laws and regulations so that MaaS services can be smoothly provided and make efforts with a view toward creating a new structure for institutional and operational easing as well as developing the required environment as needed. This can be expected to jumpstart competition toward the implementation of more convenient services by decreasing the burden on MaaS operators and making it easier to enter the market. At the same time, there is a need to research the insurance system and the state of public assistance over the medium to long-term from the perspective of decreasing the risks for MaaS operators and promoting entry into the MaaS market.

D. Backing regions that are taking on the challenge of new initiatives

<Clarification of regional needs and issues>

The state of a transportation network is defined by various factors including the geographical characteristics of the region, social and historical composition, industrial and labor structures, demographic movements, and the relationships with surrounding regions, etc. Therefore, in examining the direction of mobility, solutions which are suited to the situation in each region must

be introduced after clarifying the needs and issues of each region followed by efforts to optimize the entire region. The cooperation of the nation, local public organizations, private groups, university research institutions, and various other stakeholders can be expected at that time. However, it is important to involve the local residents to sufficiently cultivate an understanding and acceptance of the future direction.

Furthermore, at the Urban and Regional Roundtable Conference on New Mobility Services hosted by MLIT, the five regional patterns consisting of "large cities", "suburbs of large cities", "regional cities", "regional suburbs and depopulated areas" and "tourist sites" were established in consideration of the differences in characteristics by region, and the typical issues and the direction of current efforts were examined for each regional pattern.

<Support for local public organizations better able to act as the overall regional coordinator>

In many cases, the leadership and enthusiasm of local public organizations that can act as an overall coordinator of multiple regional stakeholders are the key to solving transportation issues. Therefore, it is important to selectively back solution offerings from various companies with respect to local public organizations with a flexible mindset and strong initiative in tackling regional problem-solving and improving value. For example, in December 2015, a project proposal competition to optimize transportation within cities called the "Smart City Challenge" was held in the United States. Field operational testing was conducted based on the contents of the winning proposal from the city of Columbus, Ohio, and they are providing not only financial assistance to local public organizations but also building an integrated support system including technologies from private companies.

<Community development and the links to infrastructure provision>

The relationship between cities and transportation is one of mutual influence. Therefore, determining the influence of MaaS and other new mobility services on cities of the future and verifying the consistency of the vision that the city should aim for with the existing city and transportation policies while considering them both as one and promoting planning are thought to be important.

For example, in order to increase the convenience of transportation services which span multiple transportation modes, it is necessary to remote the seamless integration of infrastructure provision and other physical spaces in addition to the seamless integration of transportation modes in cyberspace using MaaS. Therefore, conventional transport hubs which were developed on the assumption of using existing transportation modes must reevaluate the state of that development

based on changes in how the transportation hub is used according to the introduction of new mobility services.

When promoting the kind of initiatives described above, simulating the movement of people and things by using data pertaining to transportation, locating facilities and creating spaces by predicting the effects of facility implementation, transportation policies, and other smart planning methods to increase the effectiveness of community planning are valid approaches. In particular, with the ability to understand individual door to door transportation spanning multiple transportation modes, MaaS has the potential to become the optimal tool for collecting transportation data. Therefore, in anticipation of the broad deployment of medium to long-term initiatives, a renewal of the urban planning process at the working level, which takes into consideration how this data is used, also needs to be undertaken.

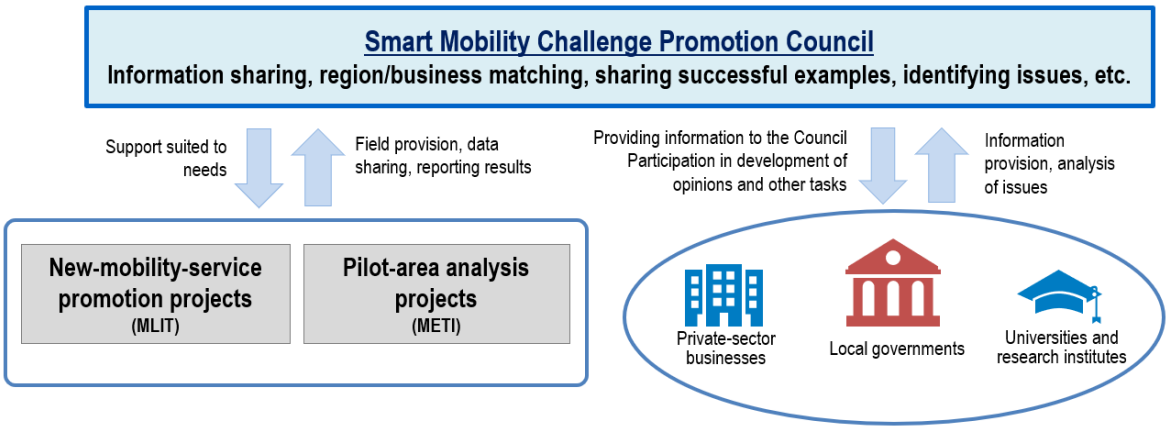
In order to create the optimal traffic flow for society based on community planning founded on this type of data as well as mobility planning, ways to encourage the transformation of individual behavior will become important. In addition to granting incentives through the MaaS rate structure ideas, etc. described above, controlling the travel time slot, volume of travel, and other methodologies for inducing individual behavior through links (issuing coupons, etc.) between MaaS and peripheral services are believed to merit consideration. In particular, it can be expected to help increase the resilience of a town during a disaster by using a MaaS app, etc. to merge real-time transportation data with transportation information, utilize its strengths as a touch point with users, and function as a way to optimally control the movement of people.

However, the majority of conventional transportation hubs are developed on the assumption that existing transportation modes will be used, and the introduction of MaaS and other new mobility services will require many hours to develop hardware in real-world spaces. Therefore, while advancing the development of transportation hubs required for seamless integration through public-private partnerships in conjunction with field operational testing of new mobility services over the short term, we should position new mobility services in a way which facilitates the realization of desirable cities and transportation based on various plans including city planning, master planning, and infrastructure provision, etc. and figure out whether sustainable initiatives can be promoted over the medium to long-term. Specifically, transportation hubs which support new mobility services, institutional studies pertaining to the development of driving spaces, and the creation of guidelines for incorporating new mobility services into city planning master plans, infrastructure provision, and other integrated plans are important for deployment to local public organizations.

In order to cooperate with companies, etc. to support regional movements which are taking on the challenge of new initiatives according to the needs and issues with respect to mobility for each region and based on cross-sector issues directed at expanded popularization of such new mobility services, METI and MLIT started a new project in April of this year called the "Smart Mobility Challenge" to

support cities and companies that are taking on the challenge of solving transportation issues and regional revitalization through the social implementation of new mobility services. The "Council for Promoting the Smart Mobility Challenge Project" was established as an organization for the promotion of new mobility services and is joined by companies and local public organizations that are proactively sharing information about the current status of their own efforts and a recognition of the issues, etc. The Council will host symposia and other events in each region to promote the sharing of information about regional and corporate initiatives and cooperation between different industries. METI will carry out business plan development and impact analysis, etc. ("Pilot Region Analysis Projects") together with regions that are engaged in the pioneering social introduction of new mobility services. MLIT will support the field operational testing ("New Mobility Service Promotion Council") of MaaS and other new mobility services in locations across the country to build models directed at solving issues in regional transportation services. The key points for improving the regional social acceptance and feasibility of new mobility services, the impact on regional economies, and institutional issues, etc. will be ironed out and linked to business environment development.

Figure 23: Council for Promoting the Smart Mobility Challenge Project[48]



48 4th Working Group Concerning New Mobility Services Enabled by IoT and AI

4 Common infrastructure

(1) Direction of advancement in infrastructure and related technologies

<Future direction of data architecture>

Changes in the business model for automated driving systems have arisen from the changes in data architecture related to automated driving[49] systems.

Adoption of IT vehicles has advanced as an embedded architecture, where along with adoption of IT in-vehicle equipment and systems, various sensors have been installed in vehicles, and based on data from [50]these sensors, in-vehicle equipment is controlled electronically.

Toward the further advance of automated driving systems, which represents the trends toward IoT, big data, and AI, the data architecture, those controls including judgment based on the data and knowledge platforms in each vehicle, is expected to become more sophisticated and evolve toward the following directions:

i. Part of the driving knowledge data, including probe data[51] and video data collected by each vehicle, is transferred to and accumulated in outside data and knowledge platforms such as cloud platforms via networks. Such data are used in various fields such as various big data analyses as well as dynamic maps[52] and base data for artificial intelligence[53].

ii. In addition to the data obtained from a large number of vehicles, part of the data and knowledge platforms, such as artificial intelligence (AI) generated from outside data including high-precision 3D maps and driving video data associated with dynamic maps, is sent back to each vehicle via networks and used as data and knowledge required to make judgments related to automated driving.

iii. As a network structure, architecture such as edge/fog computing is used.

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49 A basic design conception that segments and allocates product components according to their functions and that designs and adjusts interfaces for those components.

50 Architecture (design conception) that incorporates hardware and software into a product to achieve certain functions. Generally, there is no architectural compatibility among vehicles or manufacturers.

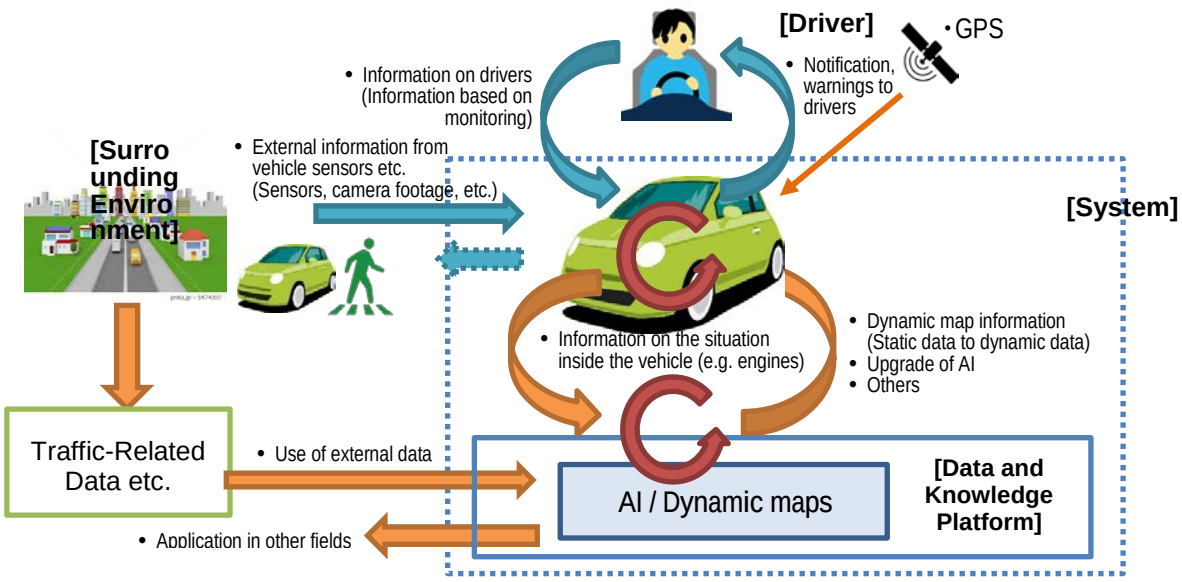
51 Probe: It originally referred to exploratory needles or sensors. It can also refer to remote monitoring devices. Information that is collected, accumulated, and analyzed as big data includes locations where the brakes were applied and locations and time where and when the wipers were turned on. Information collected by cameras and radar equipped for automated driving systems is expected to be included in the future, and this will enable the generation of sophisticated map information regarding road shapes.

52 Dynamic maps are high-accuracy 3D maps (for automated driving) linked with time-varying dynamic data (dynamic information, quasi-dynamic information, and quasi-static information). High-precision 3D maps are being developed by privately-funded infrastructure developers as a cooperative area for dynamic maps.

53 Information that is collected, accumulated, and analyzed as big data includes locations where the brakes were applied and locations and time where and when the wipers were turned on. Information collected by cameras and radar equipped for automated driving systems is expected to be included in the future, and this will enable the generation of high-precision 3D maps information.

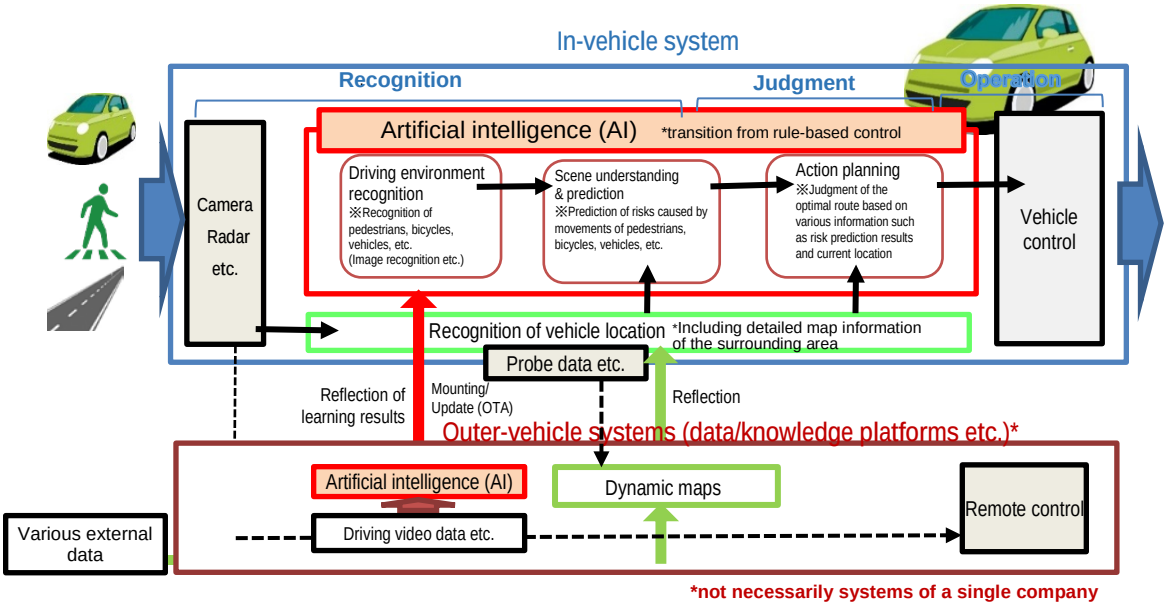
As a result, automated driving technology and the use of traffic data obtained through data platforms are expected to develop synergistically. Consequently, while automated driving systems are complementary even as they are primarily designed to enable the autonomous control of vehicles, traffic data will continue to be obtained from data platforms and used accordingly. Core technologies for utilizing such data will thus shift from conventional vehicular technology to software technology, which includes AI, and data platforms. It is also expected that the roles played by dynamic maps and cloud services utilized for the storage, processing, and provision of such maps, and communication lines, etc. will become more important as elements of these data platforms (see chapter 5).

Figure 24: Data architecture for automated driving systems (for illustrative purposes only)



Many of the automated driving systems currently used for field operational tests are mainly controlled by traditional software (rule-based control), excluding some functions such as image recognition in the driving environment recognition function. Artificial intelligence (AI) and rules-based controls will likely come together to provide scene-recognition and scene-prediction functions, action-planning functions, and other such features to enable driving actions on city streets and in other more complex settings.

Figure 25: Roles of artificial intelligence (AI) in future automated driving systems



In addition, it is thought that the role of interfaces will become more important in vehicles within the architecture of automated driving systems. Specifically, for driver interfaces[54], interfaces that enable communication between drivers and vehicles while monitoring driver conditions will be developed (in particular Levels 2 and 3). For interfaces for the surrounding environment, interfaces for the provision of information (including that collected from the aforementioned in-vehicle equipment and sensors) to and communication with pedestrians and other moving objects around the vehicle will be developed.

Artificial intelligence (AI) is expected to be increasingly used in interfaces between vehicles and drivers, pedestrians, and other moving objects around the vehicle.

Autonomous-type architecture, cooperative-type architecture, and safety assurance

In these types of automated driving systems, plenty of data concerning information surrounding the vehicles are collected from various sources and used for driving operations.

The methods to collect information surrounding vehicles can be categorized into the following: a method to obtain information via radar installed in vehicles (autonomous type), a method to use information in the information platform on the cloud via networks (mobile phone networks etc.) (mobile type), and a method to collect information via communication with equipment installed on the road infrastructure or with equipment installed in other vehicles (Narrow cooperative type. The former is a vehicle-to-infrastructure cooperative type while the latter is a vehicle-to-vehicle cooperative type).

54 Specifically called HMIs (Human Machine Interfaces).

These are not mutually exclusive technologies, but technologies that, when combined, enable more advanced driving safety support systems and automated driving systems that are based on diverse information. In fact, automated driving systems where vehicles are controlled using information obtained from sensors (autonomous type) and information (such as dynamic maps) obtained from the cloud (mobile type) are being developed[55].

Table 13: Types of information collection technology for driving safety support systems and automated driving systems

Types of information collection technology		Content of technology (method to input information)
Autonomous Type		Obtains information, such as obstacles, via radar and cameras installed in the vehicles
Cooperative Type (broad sense)[56]	Mobile Type	Collects location information via GPS. Collect information (including map information) on the cloud via mobile networks.
	Vehicle-to-Infrastructure Communication Type	Collects road traffic information surrounding vehicles via communication with equipment installed on roadside infrastructure.
	Vehicle-to-Vehicle Communication Type	Collects location and speed information of the vehicle via communication with equipment installed in other vehicles.

In the future, strategies toward the integration of autonomous and cooperative types will be particularly required as driving safety support systems develop into highly automated driving systems. Then, the automated driving systems will be based on autonomous information-based systems, where cooperative automated driving devices are added as modules[57].

55 Information collected and provided by dynamic maps is considered to be the cooperative type in a broad sense. From the perspective of automated driving, it is considered that such information complements information collected by the autonomous type such as radars and cameras and improves its reliability.
As for the methods for collecting and distributing such information, the utilization of communications through the mobile type is generally considered the most likely. However, it is necessary to discuss such methods in detail in view of future advances in technology while considering the division of roles between the mobile type, vehicle-to-infrastructure communication type, and vehicle-to-vehicle communication type.

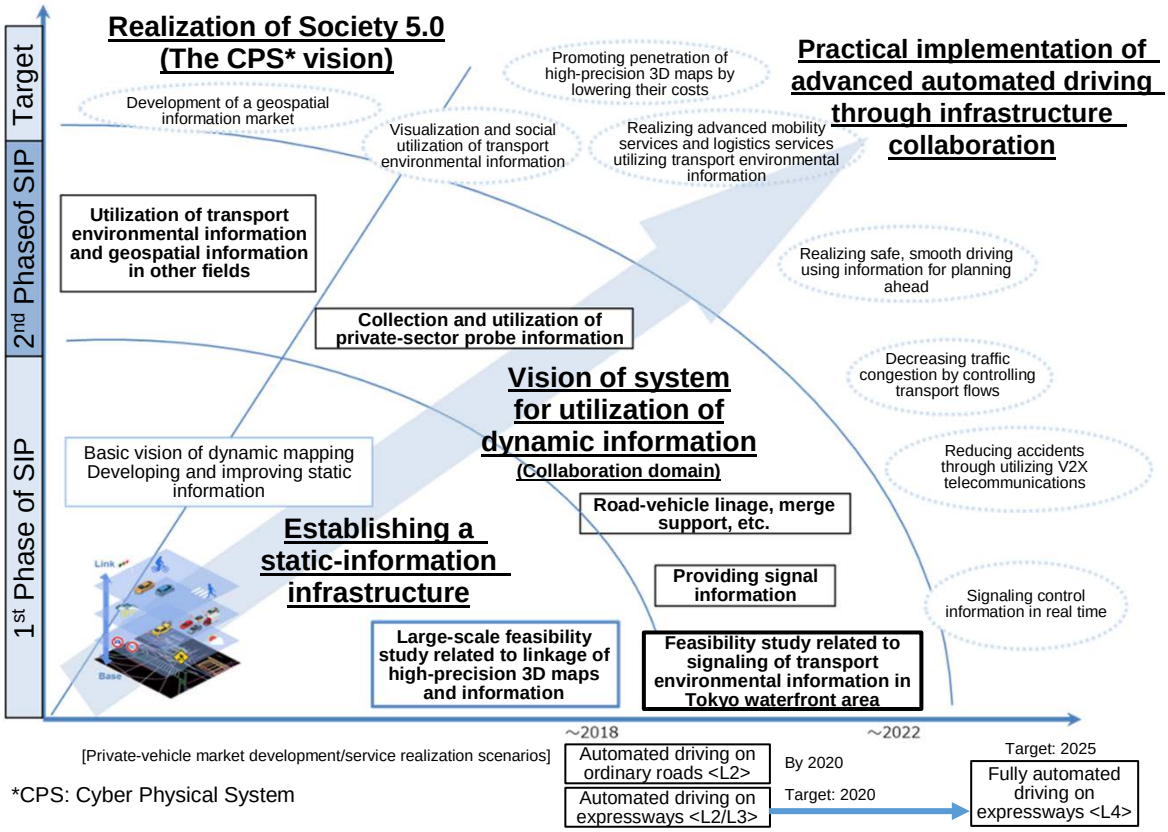
56 In this categorization, the mobile type was included in the broad cooperative type from the perspective of technology types related to information collection. (While it is not clearly defined, vehicles that use vehicle-to-infrastructure communication-type or vehicle-to-vehicle communication-type technology are sometimes called connected cars.)
For the mobile type, vehicle-to-infrastructure communication type, and vehicle-to-vehicle communication type, since these types have different real-time characteristics and popularization strategies, the cooperative type in this document shall indicate, in principle, the vehicle-to-infrastructure communication type and the vehicle-to-vehicle communication type, except the mobile type.

57 For detailed strategies for the integration of autonomous and cooperative (vehicle-to-infrastructure cooperative type, vehicle-to-vehicle cooperative type) technologies, please refer to Public-Private ITS Initiative/Roadmaps 2015.
For traffic light information that is indispensable for the realization of automated driving systems, since it seems difficult for the autonomous type to accurately detect and process such information, it is important for vehicles to ensure the detection and processing of such information by adding cooperative type functions and referring to data provided by roadside infrastructure.

<Development of a traffic environmental information framework and road transport infrastructure>

Various players are advancing initiatives directed at the social implementation of automated driving including the autonomous type and cooperative type of solutions. However, developing the ability to obtain and utilize information not only at the vehicle level but also from other vehicles and road transport infrastructure (vehicle-to-vehicle and vehicle-to-infrastructure communications, etc.) and establishing traffic control systems and other traffic environmental information framework to contribute to the optimization of traffic flow and dynamic maps that are the foundation of automated driving are important and need to be examined going forward.

Figure 26: Roadmap for traffic environmental information utilization[58]



Examples of initiatives directed at implementing the use of vehicle probe information which takes the data obtained from the onboard sensors, etc. of a certain vehicle and sends it through the cloud to other vehicles as information are seen in every country including Japan. In addition to expanding the scope of recognition of the surrounding environment which cannot be captured by the vehicle's onboard sensors and achieving a more advanced automated driving system, such

58 The second phase of SIP-adus

initiatives will notify drivers of hazards and help improve the performance driving safety support systems.

Moreover, we are also seeing initiatives to develop these elements as information sources by equipping radar, cameras, and other sensors on signals, signs, roadside units, parking lots, and other road transport infrastructure and adding communication features. Oncoming and stopped vehicles, etc. pose an obstacle particularly on roads with a high volume of traffic, and in many cases, it is difficult for "autonomous type" systems to be aware of the surrounding environment using onboard and other sensors. Efforts to build and develop traffic environmental information that uses road transport infrastructure for such situations can be said to aid in the early realization of an automated driving society.

In addition, research is also being conducted regarding the use of information obtained from the aforementioned onboard sensors and road transport infrastructure, etc. to reduce congestion by controlling signals according to the volume of traffic and to quickly respond to traffic accidents. The coming evolution of AI and IoT and the use of image data and other forms of big data will enable more efficient signal control to be carried out, which is expected to further accelerate the introduction of such solutions in countries facing severe congestion problems.

The traffic environmental information framework for collecting information from onboard sensors and road transport infrastructure, etc. to provide it as traffic environmental information will likely increase in importance in such a situation.

As data dependency is increasing with the advancement of automated driving systems, data architectures must be designed to ensure safety. Therefore, together with ensuring redundancy, multiple safety designs such as fail-safe mechanisms, and the interweaving of security measures (including required devices and operations management systems) into automated driving systems, the development of technologies and environments (testbed) to evaluate such measures are needed.

In particular, in light of the possible risks, such as errors and discontinuation, the responsibility to implement the aforementioned measures for "mobile-type," " vehicle-to-infrastructure communications," and other "cooperative type" of data shall be borne in principle by automated driving vehicles that use such data[59].

Future direction of the traffic-related data sharing platform and its use

As the importance of data increases in the era of big data, the use of data obtained from various sources as described above can be expected to contribute not only to proposals for transportation

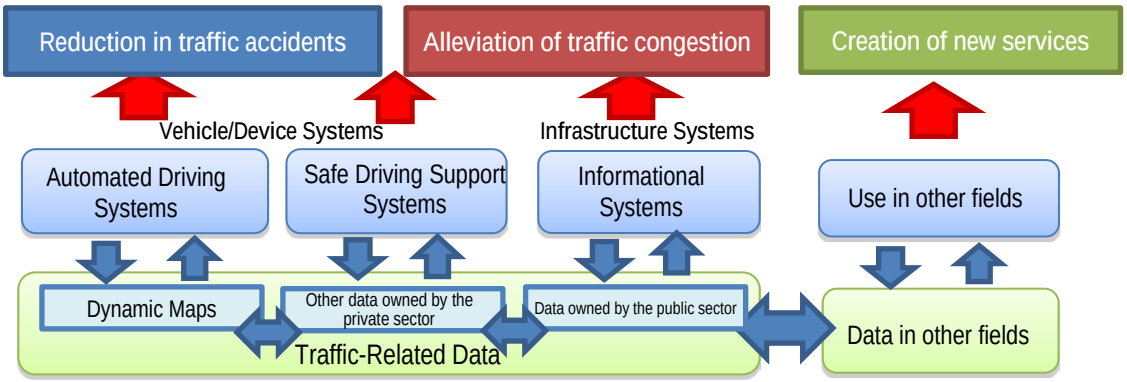
59 Safety design and measures that take risks into consideration are required for data acquired by the autonomous-type method.

related measures and the application of driving safety support systems and automated driving systems but also to the creation of new services in the tourism industry, insurance industry, etc.

Because the data obtained from onboard sensors will also increase with the evolution of automated driving systems going forward, approaches to using this data to realize the efficient maintenance and management of dynamic maps are being examined.

Until now, these public and private sector systems were individually developed in a system of vertical integration in order to achieve their respective purposes. In contrast, the architecture in the big data era will shift to horizontal specialization, and data are expected to be shared not only within each field, but also across fields, leading to the use of such data in various fields other than the traffic field.

Figure 27: Positioning of traffic-related data platforms (for illustrative purposes only)



In the midst of such a structural change, many discussions and reviews must be made regarding the development of standards and rules that enable the sharing and distribution of data, which are selected from among an enormous volume of data, via public-private cooperation and the development of systems to examine ways to make such data available to the public.

In doing so, due consideration should be given to the following facts: data is often collected within the extent of its purpose of use from individuals and the predetermined handling rules; data held by private companies have been collected from a business perspective to begin with; and the data held by the public sector will require a significant amount of additional money to build new systems and databases for the release of the data to the public.

(2) Promote R&D and demonstration testing

Strategy for R&D and demonstration of automated driving systems toward its commercialization

In order to realize automated driving systems, it is necessary to promote public-private joint R&D of the hardware and software related to a wide range of technologies such as sensing technologies, control technologies, communication technologies, AI technologies, and security technologies.

Within those efforts, the government has promoted through public-private partnerships the research and development and field operational testing of discrete element technologies and dynamic maps, information security, functional safety,[60] control, human factors[61] and other technologies with a focus on common infrastructure technologies which are not related to private competitive areas and other so-called "cooperative areas" through SIP and the policies of various ministries and agencies and based on the Public-Private ITS Initiative/Roadmaps.

Going forward, the focus should be on the demonstration (verification of technological aspects, institutional aspects, and social benefits) and standardization of each technology while considering the expansion of the R&D areas that are promoted cooperatively by private sectors toward the realization of more advanced automated driving systems. New initiatives including demonstration projects by venture companies shall be supported[62]. In addition, attention should be paid to the fact that productivity, durability, and other additional technology development is required for the transition from the demonstration stage to the commercialization stage.

Attention should also be paid to the necessity of integrating the efforts of many concerned parties in promoting the R&D of cooperative systems and information communications infrastructure that will serve as the platform for automated driving systems. Moreover, joint research by industrial, academic, and governmental actors shall be further encouraged. The use of high-precision positioning based on the utilization of quasi-zenith satellite, an area in which Japan enjoys a competitive advantage, will be investigated with a view to realizing automated driving systems.

60 It is also necessary to consider the requirements for securing safety in case of fail-operational mode (including functional degeneration), performance limit, erroneous operation, and misuse, as well as functional safety.

61 When performing driver monitoring and considering the acceptable range of secondary activity, it is necessary to standardize requirements based on basic and fundamental ergonomic research on drivers' recognition, behavior, and physiological state and its findings from the perspective of streamlining and accelerating development and securing minimum safety.

62 When developing automated driving systems and element technologies, the introduction of a reward-type method that provides a place for competition (contest) for many entities and challenging ideas shall be considered in light of the fact that it is necessary to gather ideas and advanced teams with various capabilities.

Fundamental research and human resource development for the future automated driving systems

In the future, as technologies required for automated driving systems go beyond the boundaries of conventional IT introduction into automobile technologies and become more focused on artificial intelligence (AI) and other advanced and innovative technologies, ergonomics (HMI etc.), security and other interdisciplinary fields are continuing to spread.

Therefore, because the training and securing of software personnel with knowledge of AI are essential, skills standards applicable to automotive software pertaining to automated driving will be formulated in FY2018. Moreover, courses for the cultivation of human resources based on the use of these skills standards will commence in FY2019. In addition, promoting R&D and demonstration activities for automated driving systems, the capabilities of multiple existing research institutions as well as universities will be actively leveraged to develop a system of collaboration among industrial, academic, and governmental actors in Japan[63].

In doing so, efforts shall be made to make these institutions the core centers that are open to the world from the perspective of promoting the utilization of overseas human resources and the participation of overseas companies. Through these systems, efforts shall also be made to build ecosystems that will create new ventures and industries

(3) Initiatives to develop infrastructure and related technologies

A. Initiative to build the automated driving infrastructure

<Developing a driving video database to enhance the capabilities of AI, formulating scenarios for the fortification of safety-evaluation technologies, and building an evaluation environment in a cyber space>

Amid growing interest in artificial intelligence in recent years caused by deep learning, automated driving is deemed to be one of the most important fields for AI application.

Automated driving mainly use rule-based control except for some functions such as image recognition and not all of them are driven by artificial intelligence (AI) technologies. However, based on the recognition that expanding the application of artificial intelligence (AI) is essential to realize

63 A system for R&D of artificial intelligence (AI) has been developed under cooperation between the Ministry of Education, Culture, Sports, Science and Technology (RIKEN), the Ministry of Economy, Trade and Industry (National Institute of Advanced Industrial Science and Technology (AIST)), and the Ministry of Internal Affairs and Communications (National Institute of Information and Communications Technology (NICT)) since FY2016. Discussions shall be promoted with a view to collaborating with such a system where necessary.
In addition, as for HMI, AIST established the Automotive Human Factors Research Center in April 2015 to study the attributes of humans as drivers toward the realization of safe, fun driving.

driving in more complex environments including urban areas going forward, AI is perceived to be the source of future competitive advantage for automated driving, and research is actively proceeding toward that goal.

In order to improve the capabilities of AI including deep learning and other forms of machine learning, it is necessary to have AI learn from as many driving scenarios as possible, and from this perspective, driving video data and accident data will play an important role. Until now, such data was primarily collected in Japan to evaluate onboard sensors[64].

In addition, the development of safety-evaluation technologies is an urgent matter for the introduction of highly automated driving vehicles to the market. In evaluating safety, the belief that we should not just conduct evaluations on actual vehicles being driven, as has been the practice to date, but also conduct driving evaluations using simulations is one that is internationally established[65]. In Japan as well, the Japan Automobile Research Institute (JARI) began researching methods of creating scenarios to conduct safety assessments as a METI commissioned project in FY2018 based on the use cases that have been established by JAMA since FY2016. Accident data and driving video data developed by JARI will be utilized to produce scenarios for the development and investigation of safety assessment technologies. Any new driving video data that is required for a new purpose shall be collected upon investigating the specific method of use, required resolution and other such conditions, method of data management, and other pertinent matters. Furthermore, it is expected that driving video data will also be utilized to update high-precision three-dimensional map data for dynamic map applications and applied to fields outside the realm of automated driving[66]. In the second phase of SIP-adus, we are building an assessment environment and engaged in tool development for virtual safety assessment and demonstration simulations centering on sensor performance assessment to evaluate the safety performance of automated vehicles.

Data collection and utilization will be promoted in accordance with the [67]Basic Policy on the Strategic Collection and Use of Driving Video Data and Accident Data as compiled in the Action Plan for Realizing Automated Driving (Version 2.0) (March 30, 2018)[68] as enacted by the Panel on Business Strategies for Automated Driving.

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64 The "Recognition and Judgment Database" has been positioned in Japan as a cooperative area, and we have been building a database of driving video, sensing data, and driving action data through the contract projects from SIP-adus and METI. The Projects are implemented by the companies including Japan Automotive Research Institute (JARI).

65 As seen in the German PEGASUS project.

66 It has been pointed out that footage data obtained from an automobile's cameras can be used to update high-precision three-dimensional map data for dynamic map applications as well as to visualize the environment surrounding roads and enable information-sharing by the police, firefighting services, hospitals, and other first-responders in an emergency. (Materials provided by the Committee for Improvement of Legal System for Utilization of Information and Communications Technology, IT Strategic Headquarters; November 2015)

67 Established in February 2015 as an investigative council by the head of the Manufacturing Industries Bureau of METI and the head of the Road Transport Bureau of MLIT in order to help solve various societal issues as a global pioneer in the field of automated driving.

68 http://www.meti.go.jp/report/whitepaper/data/20180330002.html

Implement and upgrade dynamic maps

Dynamic maps in automated driving are high-accuracy 3D map data linked with time-varying dynamic data (dynamic information, quasi-dynamic information, and quasi-static information). These dynamic maps are primarily used for supplementary information for self-position estimation and driving route determination.

Since it costs a great deal to establish high-accuracy 3D map data that will serve as the foundation of dynamic maps, a privately-funded infrastructure provision company[69] was established in June 2016 to promote public-private collaboration, including collaboration on the development of specifications and maps between companies. It became an operational company in June 2017, and the development of high accuracy 3D maps of all exclusive motor-vehicle ways in Japan was completed and commercialized in FY2018. After receiving additional financing from INCJ and other sources, the company announced on February 13, 2019, that procedures had begun to purchase a company which develops and owns a similar type of high accuracy 3D maps in the US to strengthen its international efforts.

In addition to such private enterprise initiatives, technology development is being pursued in connection with the policies of each ministry with a focus on SIP-adus that includes technologies to provide signaling information, merging assistance and other technologies, technologies to collect and utilize vehicle probe information, and technologies for deploying traffic information for many purposes. Specifications of dynamic maps discussed in SIP-adus are now being internationally standardized such as ISO standards and efforts are being made to ask overseas related standardization organizations to harmonize specifications. It is necessary to strongly promote the international standardization of those specifications so that dynamic maps can be used smoothly in Japan and overseas.

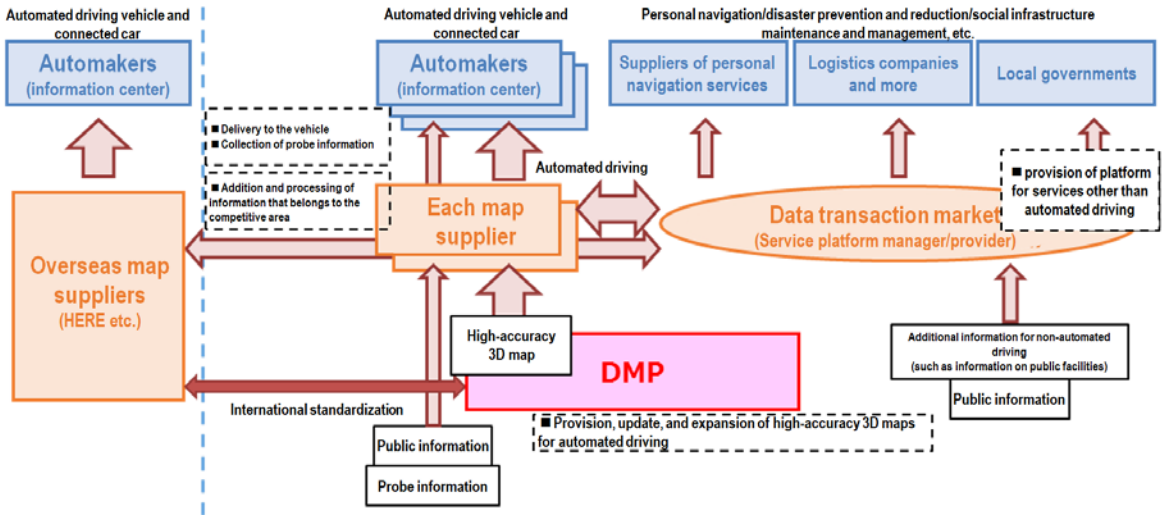
In addition, efforts are being made to achieve intersystem coordination and cooperation keeping in mind that the advanced map information infrastructure related to dynamic maps can be utilized not only for automated driving systems but also for pedestrian movement support and non-traffic related fields such as disaster prevention, tourism, and road management. Specifically, the

69 Dynamic Map Platform Co., Ltd. (DMP) was established in June 2016 as a planning company, consisting of six companies from the Dynamic Map Development Consortium that have investigated specifications of dynamic maps in the first phase of SIP-adus and automakers and became an operational company in June 2017. DMP is aimed at considering development, demonstration, and operation of high-accuracy 3D map data (shared platform that is a cooperative area of dynamic maps) that are required to realize automated driving/driving safety support systems. It sets a goal of becoming a business corporation within 2017. It aims to expand dynamic maps not only in the field of automated driving/ driving safety support but also in a wide range of fields such as disaster prevention and reduction and social infrastructure maintenance and management.
* In realizing automated driving, high-accuracy 3D map data of roads and their surrounding environments are important for self-position estimation and driving route determination as well as autonomous-type information. However, since it costs a great deal for individual companies to develop such maps, they were positioned as an area that each company should work together on. To this end, DMP was established.

development of the following information distribution structure for dynamic maps and the advancement of dynamic maps will be promoted together with international standardization.

- Build a data distribution platform that enables high-accuracy 3D maps to be used in other fields
- Secure interoperability with maps of other countries by promotion of international standardization

Figure 28: Information distribution structure for dynamic maps currently under consideration (image)[70]



In addition, ways to utilize data related to automobile-related information held by the public and private sectors for dynamic maps (including development into open data) are being discussed. The practical application of a dynamic map service platform was discussed in FY2018, and a report was put together.

Table 14: Future direction of the utilization of information related to dynamic maps through public-private collaboration (image)

- <u>Considerations with regard to the provision of automobile-related data held by the public sector</u> (including development into open data)
  - ✓ Target data should be identified by clarifying the needs of private sectors including clarification of whether the data is required for automated driving (including high-accuracy 3D map information) and whether it is currently difficult for private sectors to obtain such data.
    (The following are just examples. Specific discussions will be held.)
    - ➢ Information on updating of 3D map information such as alterations to roads
    - ➢ Other data that are required for automated driving and suit private sectors' needs
  - ✓ Then, provision of such data should be considered including with regard to the clarification of the future schedule in light of the current methods for collecting and holding various data in the public sector and an appropriate, efficient information provision structure.

70 The figure shows the image of the structure under consideration, and the details may be modified in the future.

- ✓ If possible, provision of data other than the above should be promoted and it also should be made open.

- Utilization of automobile-related information held by private sectors (automakers, business operators, etc.) (Probe data etc.)
  - ✓ Specifications and structures (cooperative area) for the utilization of dynamic maps should be clarified promptly to facilitate establishment of business models in private sectors.
  - ✓ Then, the current methods for collecting and storing various data should be sorted out and efforts should be made through public-private collaboration, taking into account past efforts.
  - ✓ In addition, the possibility of the utilization of driving video data in dynamic maps should be examined.

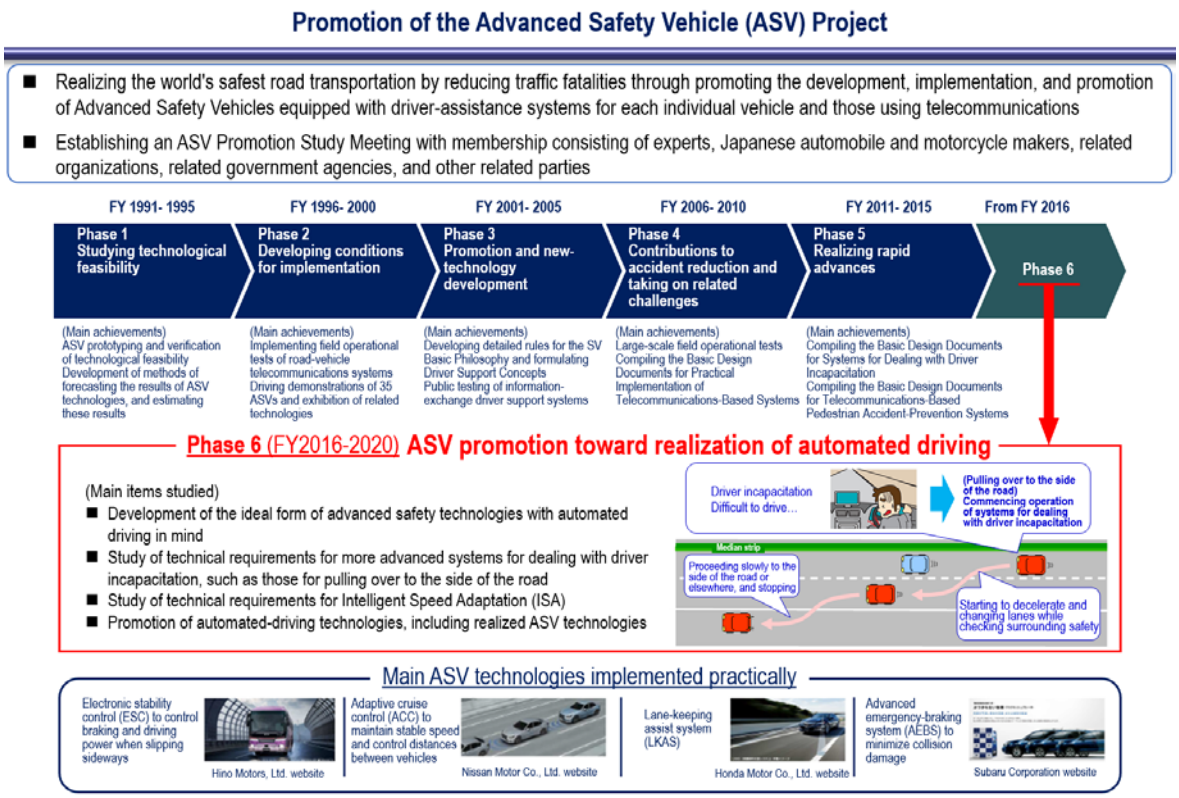
Going forward, links to other fields using geographical data, international standardization, and other efforts will be promoted in coordination with the policies of various ministries in the second phase of SIP-adus based on the direction of efforts and issues in MaaS and other new mobility services.

<Promotion of the Advanced Safety Vehicle (ASV) project>

MLIT has been promoting the development, practical application, and popularization of ASV through collaboration among industrial, academic, and governmental entities since FY1991. During FY2018, MLIT examined (1) strategies for the full-scale popularization of ASV technologies that have been put to practical use and (2) the technical requirements for "road shoulder retreat type and other developmental Emergency Driving Stop System (EDSS)" in regard to advanced safety technologies required for the realization of automated driving based on the Sixth ASV Promotion Plan. Furthermore, as a measure to prevent confusion on the part of users, the ASV Promotion Advisory Council (composed of members from industry, academia, and the government) decided to use the phrase "driver assistance vehicle" instead of "automated driving vehicle" with respect to "vehicles equipped with technologies to partially automate driving operations" in commercially available "Level 1 and 2" systems.

ASV will continue its efforts to promote the realization of automated driving.

Figure 29: ASV promotional plans



B. Development and utilization of traffic-related data and automobile-related data

Efforts toward the effective use of probe data

In recent years, data collected from moving objects (automobiles) is expanding because of the progress in IoT to include probe data, such as location and speed information of automobiles, sensor and image information, and in-vehicle operation information. However, since this data is held separately by the public and private sectors[71], and systems are developed separately except in times of disaster by each entity, and mutual connectivity has not been established.

In the private sector, these data contribute not only to providing information to automobile users, but also to creating new business and the sophistication of existing business, including the sophistication of logistics systems of forwarding companies. In the public sector, these data can be used for surveys and studies on roads and road traffic management and serve as useful information

71 For example, data are being collected and accumulated separately on unique systems of a variety of private companies, such as automobile manufacturers, public transportation, and forwarding companies, automobile-related equipment (car-navigation systems) manufacturers, smartphone and tablet OS manufacturers, app manufacturers, and insurance companies. Moreover, traffic administrators and road administrators also collect data on automobile traffic through sensors installed in roadside infrastructure, such as vehicle detectors, optical beacons, and ETC 2.0. The government, auto dealers, and automobile maintenance/repair companies have inspection registration information and maintenance/repair information.

in policy efforts, such as logistics, disaster prevention, and tourism. Therefore, the effective use of these data through sharing between the public and private sectors is much expected. Therefore, ETC 2.0 data will also be utilized to facilitate the introduction of operation management support services for trucks and other vehicles and highway bus location systems, provide maps based on automobile transit history information during disasters, and an examination of measures to deal with congestion affecting local tourism while also promoting the creation of new services in the private sector by using ETC 2.0 data in public-private partnerships. Efforts are also being made to strengthen regional mobility services, and testing and implementation will be carried out after examining the institutional and technical issues concerning practical application while coordinating with proponents of private sector services selected through a public call for proposals.

In order to promote the utilization of data held by the public and private sectors through information linkage, standards, rules, and methods required for shared use when information is distributed, including the promotion of information distribution by linking high-accuracy 3D maps of dynamic maps mentioned above with various dynamic data, shall be discussed[72].

In addition, when promoting efforts related to information linkage for probe data, it is necessary to pay attention to the trend of international standardization including de facto standards, and active involvement in international standardization is required.

Efforts toward the effective use of automobile-related information

In light of the expectation that safety and security related to the use of automobiles can be enhanced and that new services can be created by leveraging automobile-related information such as information on automobile inspection and registration, checking/maintenance, and driving characteristics, we will work to achieve the four service menus set forth in “the Future Vision Related to the Utilization of Automobile-Related Information” developed by MLIT in January 2015. Specifically, the following will be addressed: the development of a draft of standard specifications for the external fault diagnosis devices for safety-related vehicle equipment; the popularization and recognition raising activities for automobile insurance programs that promote drivers' safe driving by leveraging information on driving characteristics such as sudden acceleration and braking; the examination of a business scheme for services that summarize and provide vehicle history information including information on checking and maintenance of the automobile and traveling distance; and the sophistication and streamlining of inspections and maintenance via correlation analysis between checking and maintenance.

72 Since methods for information linkage and issues related to them and data that should be shared vary greatly depending on purposes of use and so on, it is necessary to clarify the scope of data that needs to be shared based on a due consideration of the needs of the public and private sectors such as disaster prevention and tourism. By sorting out the current methods for collecting and holding various data related to such fields and taking into account the past efforts related to information linkage, efforts shall be made under cooperation between the public and private sectors including private organizations with knowledge on such information linkage.

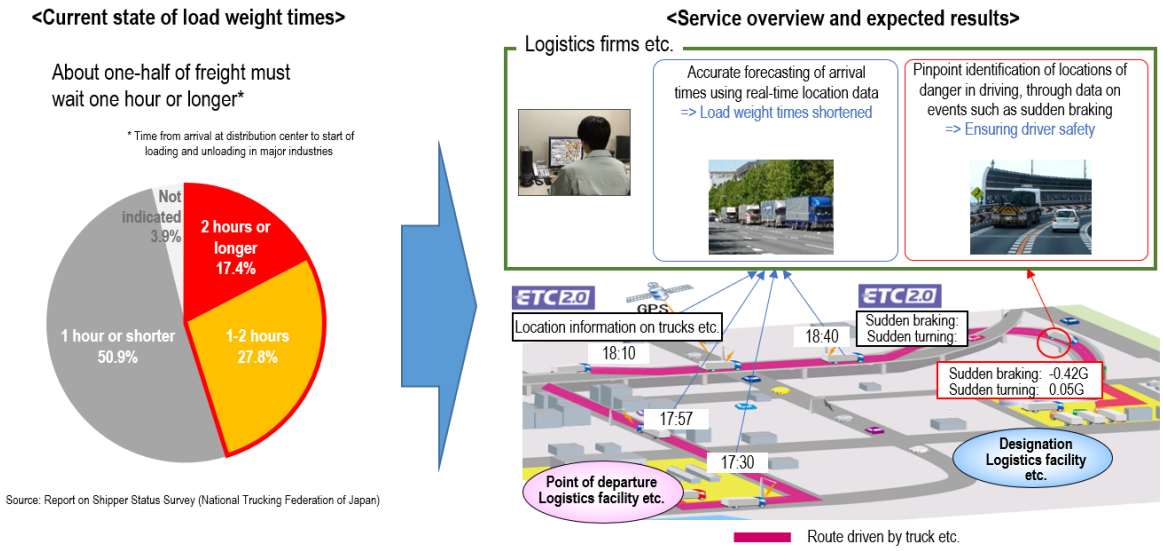
<Promotion of vehicle-to-vehicle, vehicle-to-infrastructure, and vehicle-to-pedestrian cooperation>

Other initiatives being pursued by various ministries and agencies include attempts to utilize vehicle-to-infrastructure communications and other road transport infrastructure for the purpose of the social implementation of automated driving, operation management efficiency, and ensuring driver safety, etc.

In addition to vehicle-to-vehicle communications, initiatives using vehicle-to-infrastructure communications are also being promoted by various ministries and agencies. As ETC2.0, MLIT is providing congestion information, driving safety support information, disaster support information, etc. through the roadside units (communications antennas) installed on expressways and two-way communication with the onboard ETC2.0 units in addition to the conventional toll collection features. Moreover, a full-scale introduction of the vehicle operation management support service, which provides location information and other vehicle data collected from roadside units to companies, has been underway since August 2018. Currently, roughly half of all truck drivers in Japan spend one or more hours waiting[73] for cargo, which is one factor in the long working hours of truck drivers. Extracting the driving position and sudden braking data (specific probe data[74]) for a specific vehicle equipped with ETC2.0 and providing that data to service and logistics companies through a data distribution company will enable accurate forecasting of the arrival time through an understanding of the real-time location information and the identification of dangerous driving areas through sudden braking information, etc. which can be expected to shorten the cargo waiting time, ensure driver safety, and other productivity improvement benefits.

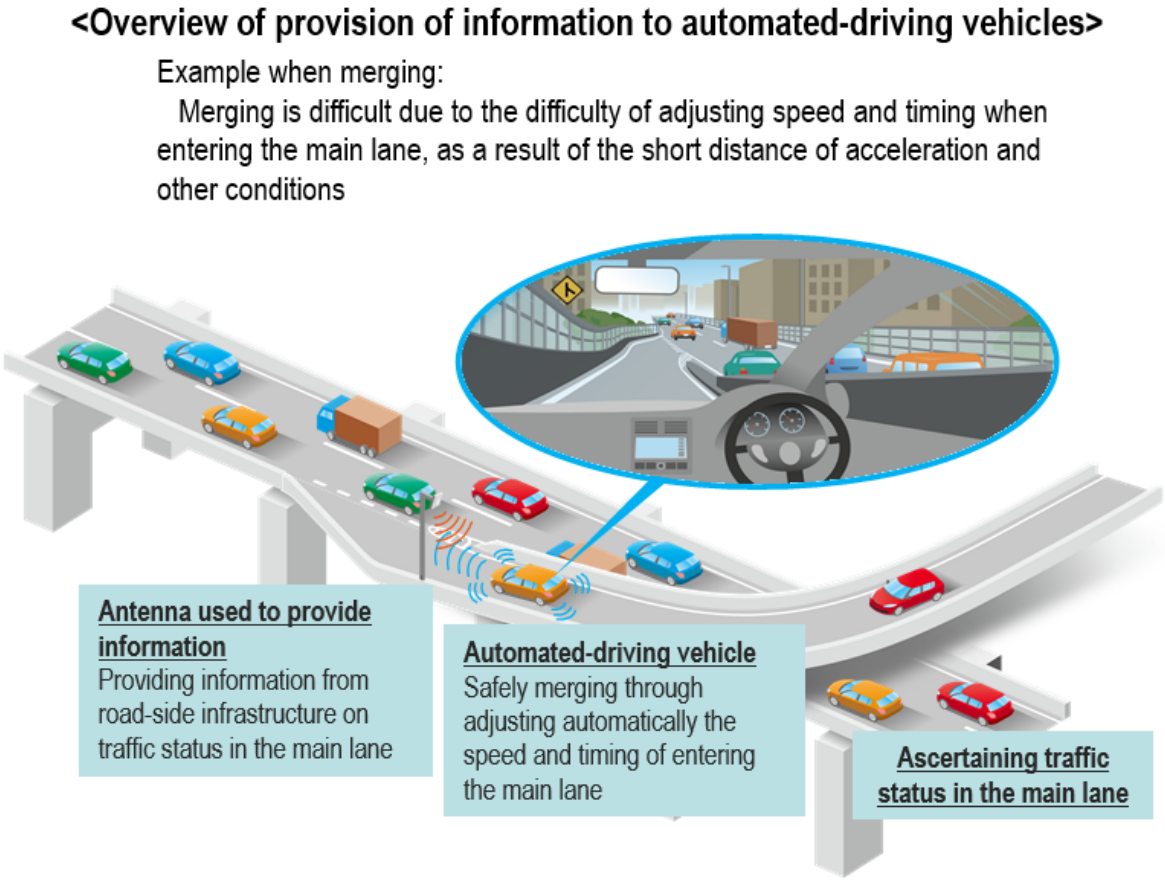
73 Time from arrival to the start of cargo handling at distribution centers in major industries
74 Data extracted from specific vehicles according to applications from companies, etc.

Figure 30: ETC2.0 vehicle operation management support service



In addition, the MLIT Road Bureau is conducting joint research to provide information about the traffic status in the merging destination traffic lane which is required for automated driving in interchange merging areas and mechanisms to provide information from roadside units to support the realization of automated driving. Because the traffic situation on the main roadway at an interchange or other merging point is unknown, there are cases in automated driving where it is not possible to safely and smoothly merge as well as cases where vehicle accidents, etc. can only be discovered immediately before the location where there is no room to automatically change lanes. In response to this situation, we are investigating ways to build mechanisms and systems to handle these issues by providing information from roadside units. In the second phase of SIP-adus, we are examining technologies needed for interchange merging areas and ETC gate passage support in the Tokyo waterfront area.

Figure 31: Illustration of providing information to automated driving vehicles (merging area example)



The National Police Agency/Cabinet Office SIP is conducting research and development to provide signaling information using roadside infrastructure and the cloud, etc. as an improvement to signaling information technology for the realization of automated driving. In order for automated driving vehicles to drive on ordinary roads, they must be able to recognize traffic signals installed at intersections and drive safely in accordance with the traffic signals. However, among the current vehicle autonomous sensing technologies, only cameras are able to recognize traffic signals. This research and development will complement the camera information by providing signaling information that uses roadside infrastructure and other wireless communications, which can be expected to realize a more advanced form of automated driving by providing the remaining number of seconds for signals and other lookahead information that the camera cannot capture from the roadside infrastructure, etc.

Figure 32: Providing signaling information through roadside infrastructure (ITS wireless roadside unit)

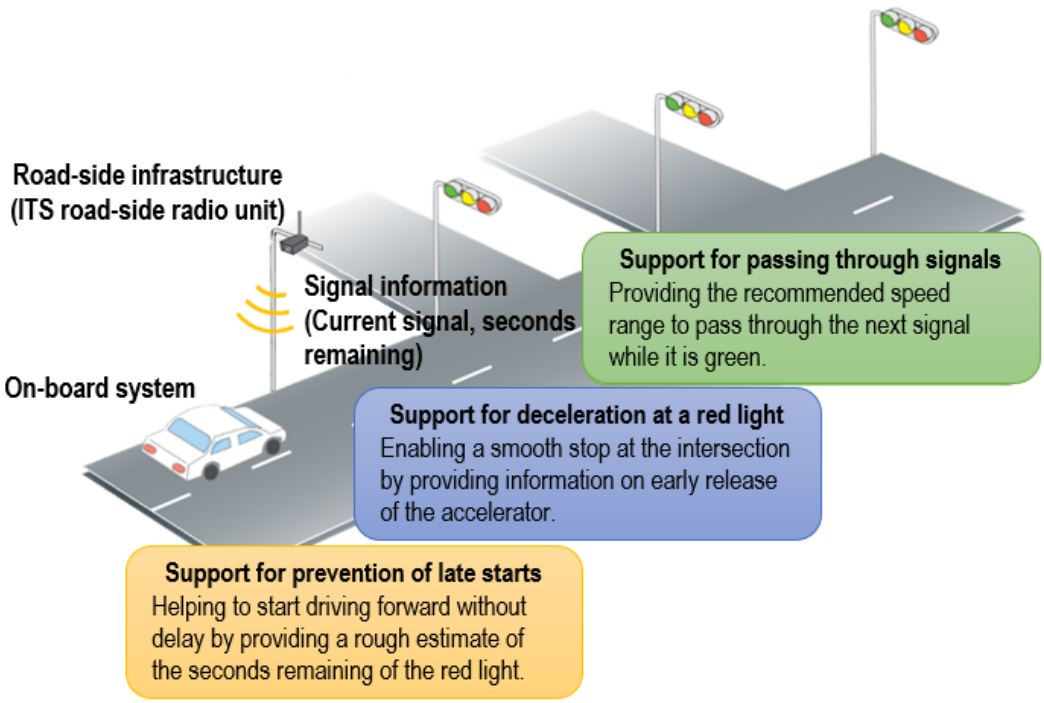
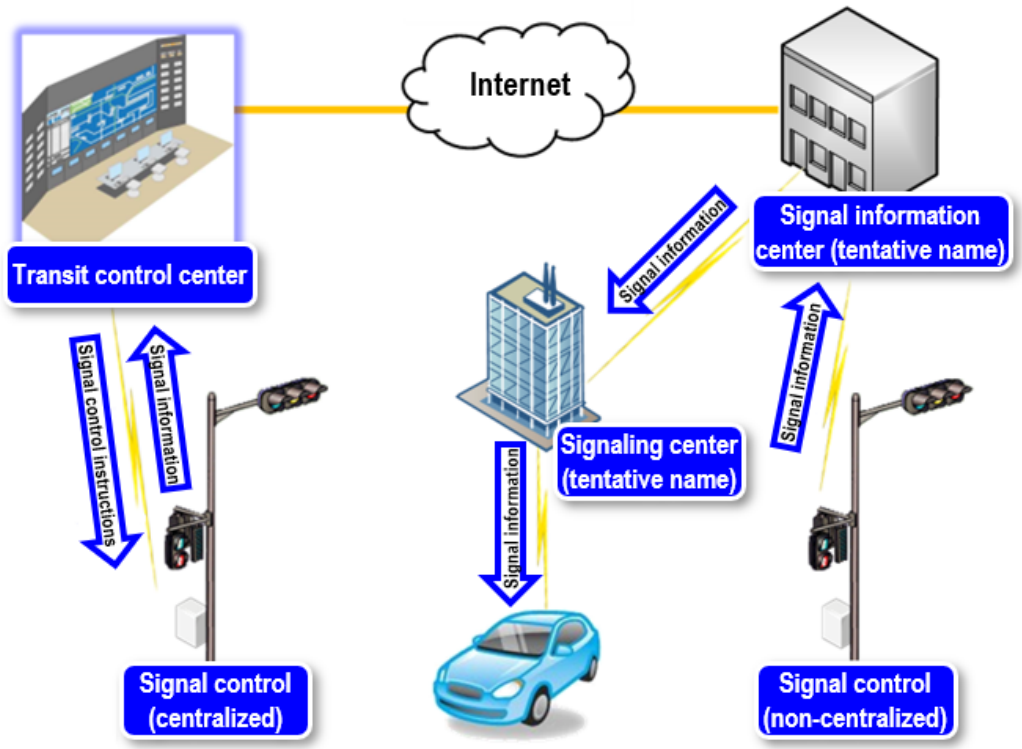
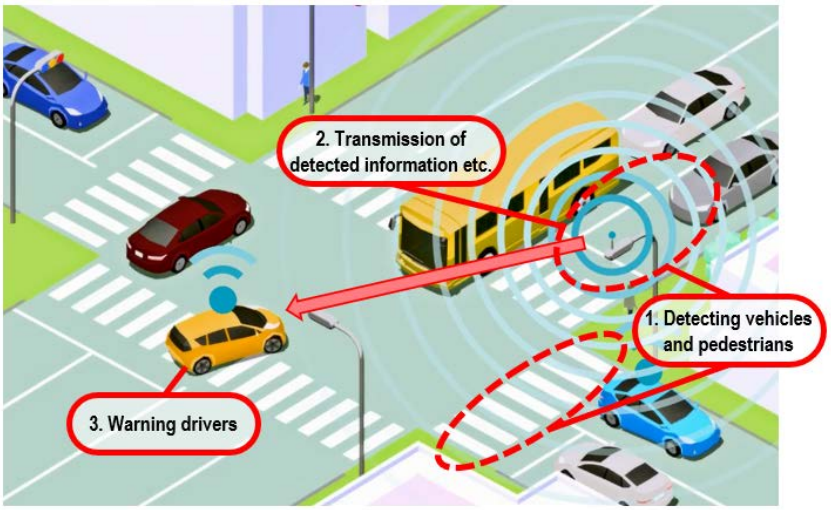


Figure 33: Providing signaling information using the cloud, etc.



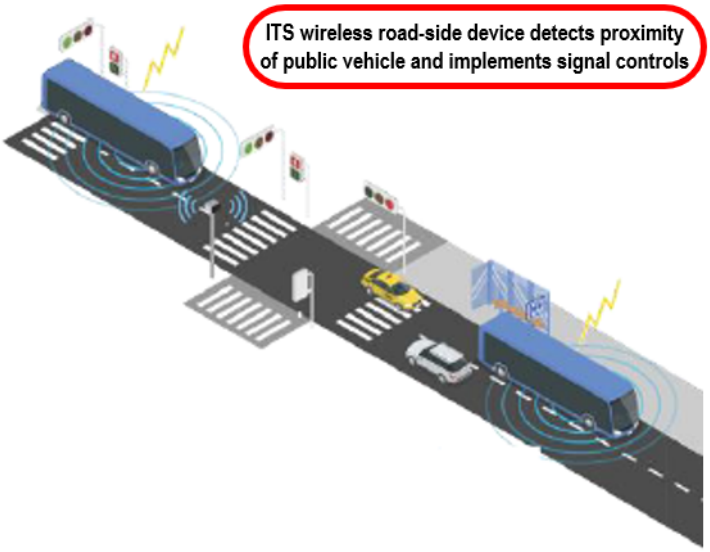
Moreover, roadside infrastructure equipped with sensors is being installed near signals to detect vehicle and pedestrian information after left and right turns in addition to delivering signaling information to vehicles, and driving safety support that uses road transport infrastructure is being provided to alert drivers and attempt to ensure safety within a traffic mix of automated driving vehicles and regular cars.

Figure 34: Driving safety support using roadside infrastructure (ITS wireless roadside unit)



In addition, an initiative in which roadside infrastructure will detect the approach of public vehicles registered in advance and control the signals is also being examined to enable priority passage of vehicles and can be expected to provide a smooth means of transportation through highly public vehicles.

Figure 35: Signal control that prioritizes public vehicles using roadside infrastructure (ITS wireless roadside unit)



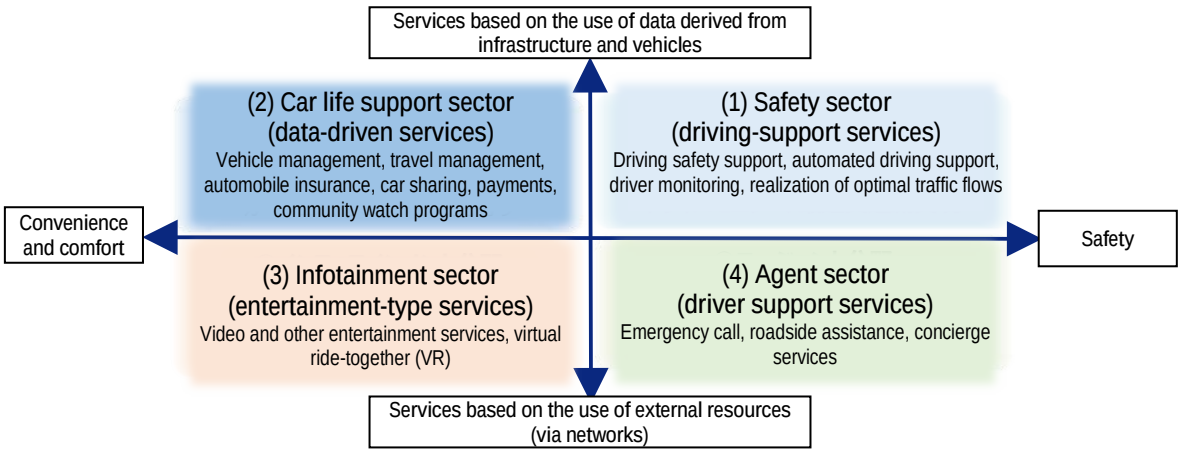
In the second phase of SIP-adus, this road transport infrastructure will be installed in the Tokyo waterfront area in cooperation with related ministries and agencies. Field operational testing on public roads will be held before and after the Tokyo 2020 Olympic and Paralympic Games with the participation of foreign and domestic automobile manufacturers, automobile parts manufacturers, and universities etc. to verify the features and requirements which should be included in such road transport infrastructure and to lead the discussion of international standardization.

[Upgrade information communications infrastructure]

Various investigations that use data obtained from cars and road transport infrastructure are proceeding in this manner, but they are all predicated on the communications infrastructure.

With the advancements in mobile network speed and capacity, IoT, big data, and AI, etc. due to the full-scale rollout of fifth-generation mobile communications systems (5G), it is expected that we will see connected cars (connected to networks) expand rapidly around the world, and progress in terms of the creation of new services and businesses spanning a wide range of sectors, including the automated driving sector, the sector for improving safety, the car life support sector, the infotainment sector, and the agent sector[75].

Figure 36: Service categories (examples)



In addition, investigations are being conducted for the promotion of commercialization with respect to 5G not only in Japan but also in other countries with a view to realizing 5G in 2020. In the 5G era, 5G systems are expected to be utilized not only in businesses based on traditional devices such as smart phones but also in new fields such as IoT, automobiles, industrial equipment, and smart

75 Accordingly, the Ministry of Internal Affairs and Communications held panel sessions for realizing a connected car society from December 2016 to July 2017 and drafted a written report.

meters. In the ITS field, serious discussions on the commercialization and popularization of automated driving utilizing a wireless system such as 5G are being held in Japan and abroad.

The upgrading of information and communications infrastructure will become essential in particular for the realization of automated driving, given that it is expected that the autonomous collection of peripheral information and the real-time transmission and transfer of large amounts of data, including dynamic map-related information, through cloud services and other external data platforms via Networks will become necessary.

It will be necessary to examine elements of the information and communications infrastructure, including with respect to edge computing and other aspects of architecture and the full-fledged utilization of 5G, while maintaining a focus on requirements in such terms as data-transfer amounts and real-time performance needed for automated driving and connected cars and the timing at which such requirements will be realized. To this end, we will promote efforts to enhance the reliability and precision of automated driving controls and surveys, studies, research and development work, and field operational testing with respect to technologies for updating dynamic map-related information and probe information on a highly efficient, real-time basis as well as technologies and systems for distributing information to vehicles with a view to quickly realizing highly automated driving systems based on the use of new communications technologies (such as V2X technology) and mobility and logistics services based on the use of automated driving technologies.

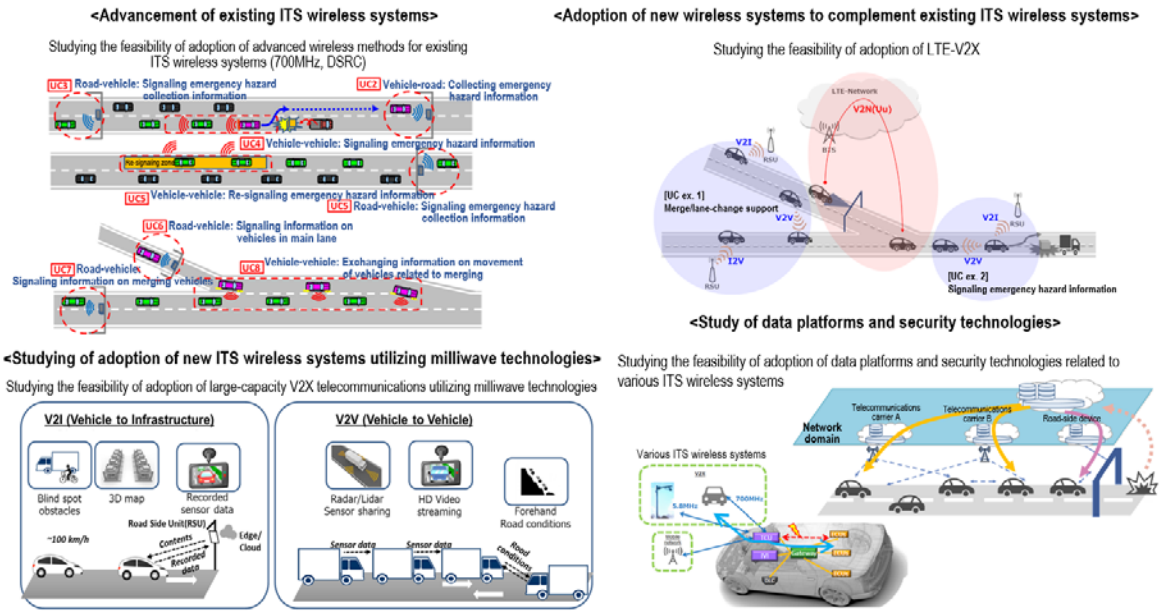
In addition, initiatives by private-sector companies pertaining to activities for automated driving systems and connected cars that are based on the use of mobile telephone technologies[76] are intensifying. The development of 5G and other elements of an information and communications infrastructure thus needs to be pursued in order to satisfy needs relating to automated driving systems and connected cars in light of research and development work being undertaken around the world for the realization of automated driving systems that utilize not just conventional ITS frequencies but also LTE and 5G networks. Also, it should be paid attention to the increasing importance of ensuring security and privacy as connected cars increase.

Regarding the upgrading of information communications infrastructure, the Ministry of Internal Affairs and Communications is taking the lead in investigating the establishment of communications infrastructure. For example, in anticipation of the realization of the V2X system, the ministry is examining the upgrading of existing ITS that use Dedicated Short Range Communication (DSRC),

76 Examples, such as the use of LTE V2X and the establishment of 5GAA, can be seen around the world.
An LTE V2X: LTE-based communications technology intended for use with automated driving systems and connected cars (such as for vehicle-to-vehicle and vehicle-to-infrastructure communications). Endorsed by the likes of Qualcomm, Huawei, Ericsson, and Nokia as of the end of 2015. Initial specifications were formulated in September 2016.
5GAA: 5G Automotive Association. Established in September 2016 to enable Audi, BMW, Daimler-Chrysler, and various telecommunications and semiconductor manufacturers to collaborate with one another on the development of services for connected cars using 5G.

LTE-V2X, and millimeter wave communication and the introduction of data platforms and security technologies relating to various ITS wireless systems. Furthermore, the ministry is also promoting international deployment so that Japan's ITS wireless system may be adopted in the future by various countries as a system which complies with international standards.

Figure 37: Improvement of legal system of various IPS wireless systems



Utilization of big data, including traffic data, for policies

In parallel with the efforts to promote and sophisticate the superimposition of the aforementioned map data and to promote the utilization of probe data, efforts to resolve issues in the traffic and other fields by leveraging traffic-related data and other big data shall be promoted.

Specifically, efforts to use roads cleverly by leveraging a variety of detailed big data, including speed and behavior data of ETC 2.0 and advanced optical beacons, in an integrated manner shall be rolled out, and efforts to apply such data to traffic policies, such as the activation of public transportation and the mobility support to pedestrians, shall be promoted. In addition, in an effort to secure efficient mobility means in rural and underpopulated areas, the popularization of on-demand vehicle dispatch systems via collaboration with vehicles operating in local communities by leveraging IT (public transportation systems) shall be examined. In order to reduce impediments to road traffic caused by significant snowfall, ETC 2.0, the Japan Road Traffic Information Center (JARTIC), VICS information, SNS, and other resources will be utilized to ensure the proper delivery of emergency announcements relating to significant snowfalls, information concerning traffic conditions and road closures, and camera footage with which snowfall conditions can be verified to road users.

In addition, initiatives based on the use of ICT and other new technologies will be pursued—such as by adopting systems to automatically detect and predict traffic hazards through the use of cameras and AI—for the purpose of streamlining the collection and provision of information. For promoting these efforts, making data to be used (including data other than traffic data) in the efforts open shall be encouraged if appropriate, and the shared use of standard systems and the use of the cloud shall be considered to facilitate the efficient introduction and popularization of systems in each region.

C. Response to privacy and security

Development of a review system for personal information protection and privacy

Since data utilization in ITS/automated driving has been expanding, it is necessary to give due consideration to the protection of personal information and privacy when using data. In particular, the automobile industry has pointed out that, when utilizing a variety of data in automated driving systems, there are issues to solve, such as the securing of consent from individuals on acquisition of their personal location information by the system and how information concerning surrounding vehicles and pedestrians, which is contained in camera data, should be handled.

The Act Partially Amending the Act on the Protection of Personal Information[77], which was amended and promulgated in September 2015 and implemented in May 2017, allows private companies to freely use anonymized information (processed so that no individual will be identifiable from it). The examples of methods for processing probe data are shown in the report[78] published by the Personal Information Protection Commission in February 2017.

In addition, regarding privacy protection related to camera images, a guide[79] was published in January 2017 in order to promote the utilization of camera images based on their characteristics. It summarizes the matters for business operators to consider when they try to protect citizens and their privacy and communicate with them properly. After that, the guide was amended in March 2018[80].

In view of these, it will be necessary to promote the utilization of probe data and driving video data. In doing so, it is crucial not only to consider legal compliance but also to make it clear that the services that utilize personal data will be useful for the individuals who provide their personal data.

77 The Act Partially Amending the Act on the Protection of Personal Information was promulgated in September 2015. The Personal Information Protection Commission was established based on the act in January 2016. (Fully implemented in May 2017)
78 "Anonymized Information: Toward the Realization of Both the Promotion of Utilization of Personal Data and the Securing of Consumer Confidence" (February 2017: report by the Personal Information Protection Commission)
79 "The Guide for Camera Image Utilization ver. 1.0" (IoT Acceleration Consortium, MIC and METI, January 2017)
80 "Guidebook Governing the Use of Camera Footage ver2.0" (IoT Acceleration Consortium, MIC and METI, 32018)

<Development of a system related to security>

With future advances in the computerization of automobile control systems, especially advances in automated driving technologies via cooperative systems including mobile-type systems, security risks will be increased and the impact of cyber-attacks on road traffic society will become greater. Therefore, interest in automobile security measures including countermeasures against hacking has been growing. In light of the fact that automobile security issues may not only cause damage to owners or drivers of automobiles but also make them victimizers, security measures are an especially serious challenge to tackle.

Against this backdrop, the formulation of industry guidelines pertaining to security measures for automobiles is being pursued in Japan ahead of international regulations[81]. Japan is advancing discussions on international standards while chairing, jointly with the United Kingdom, the cybersecurity task force that has been established under the purview of WP29. Research and development work is being undertaken broadly through the SIP-adus and initiatives being led by the Ministry of Economy, Trade and Industry and Ministry of Internal Affairs and Communications. In particular, penetrations tests from the perspective of a hacker are being carried out through the SIP-adus in large-scale field operational testing of automobile cyber security. Security evaluation guidelines were established in FY2018. In addition, an evaluation environment (testbed)[82] was set up in FY2018 within JARI through a METI commissioned project. Starting from FY2019, practical application, including the use for human resource development, will be promoted. In addition, appropriate security measures for connected cars will be discussed from the perspective of information and communications. Moreover, the permit system for applying software updates to automated driving vehicles, etc. via communications has been examined. However, we should keep in mind that we need to constantly reinforce security measures through ongoing research and development work in accordance with external circumstances.

Moreover, it is necessary to establish a system to share information between companies for incident response to strengthen security measures. To this end, we will need to pursue collaborations with the US Automotive Information Sharing & Analysis Center (Auto-ISAC)[83] and promote initiatives for prompt information sharing and analysis with respect to a system for sharing information[84] that has been set up with JAMA.

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81 Evaluation guidelines to be implemented by OEMs and suppliers are being gradually formulated by JASPAR.

82 Currently being established as a Research and Development and Verification Program for the Social Implementation of Highly Automated Driving Systems (METI, MLIT).

83 In the United States, the American automotive industry (Alliance of Automobile Manufacturers) and others announced the establishment of Auto-ISAC in July 2015. (Information Sharing and Analysis Centers (ISAC): These are organizations that work to reduce risks and enhance toughness by collecting, analyzing, and sharing information pertaining to security threats.)
Subsequently, the National Highway Traffic Safety Administration and eighteen automotive companies adopted the Proactive Safety Principles 2016, which includes provisions on automotive cybersecurity. Automotive cybersecurity measures in these principles include Auto-ISAC support and expansion.

84 The J-Auto-ISAC WG was established, whereupon its activities were commenced in April 2017.

In addition, the promotion of the cultivation of cybersecurity personnel, whose shortage constitutes an acute problem in Japan, is an urgent matter. These days, industrial, academic parties and governmental are collaborating to hold courses and programs for the cultivation of human resources.[85] We will need to proactively engage in initiatives to expand the ranks of cybersecurity personnel, including by way of scouting and recruiting mid-career overseas workers.

Progress updates on these matters and a schedule for pursuing the production of a framework for internationally common development processes and safety evaluations have been summarized in Cybersecurity Measures for Automated Driving Systems[86] by the Panel on Business Strategies for Automated Driving.

85 Including the IPA's Industrial Cybersecurity Center Personnel Cultivation Program and the Automotive Cybersecurity Course, which is offered as part of the Human Resources Cultivation Program by the Society of Automotive Engineers of Japan, Inc..

86 http://www.meti.go.jp/committee/kenkyukai/seizou/jido_soukou/pdf/sankou_002.pdf

5 Method of and Structure for Moving Forward

In the future, detailed examination will be made on the issues shown in the Initiative/Roadmaps through public-private collaboration, and the joint meetings between the second phase of SIP-adus Promotion Committee and the Road Transport Working Group will be held about twice a year as part of the public-private collaboration promotion system to promote the ITS/Automated Driving related measures, where the future direction will be examined and the roadmaps will be reviewed based on progress in research and development. The joint meeting shall comprise members from related ministries, agencies, and industries, and the Cabinet Secretariat and the Cabinet Office will serve as the secretariat.

Expert meetings will be set up and established under the purview of the IT Strategic Headquarters. With respect to the Charter for Improvement of Legal System and Environment for Automated Driving Systems, follow-up meetings will be held every half year for the time being, and institutional reviews will be subject to ongoing studies that will, in part, encompass matters to be subjected to continuous investigations in accordance with the actual state of progress in terms of technologies pertaining to automated driving. In addition, the goals of the Outline for Improvement of the Legal System and Environment will be periodically reevaluated based on discussions surrounding foreign and domestic institutions and the trends in technology development.

Through examination under the public-private collaboration promotion system, the details of Public-Private ITS Initiative/Roadmaps shall be examined and revised on an as-needed basis while considering progress and trends in new ITS-related industries and technologies in Japan and in the world and promoting the practice of the PDCA cycle in the examination.

6 Roadmaps

Public-Private ITS Initiative/Roadmap 2019 (Roadmap overview)

		FY	Short-term 2019	Short-term 2020	Mid-term 2021	Mid-term 2022	Mid-term 2023	Long-term 2024～25	Long-term 2026 ～ 30
Initiatives pertaining to commercialization	[Private motor vehicles]	Driving safety support systems	Develop for commercialization		Commercialize advanced driving safety support systems		Develop market		
		Automated driving on ordinary roads (level 2)	Develop for commercialization	Commercialize automated driving on ordinary roads	Develop market and further upgrade				
		Automated driving on expressways ・Semi-autopilot (level 2) ・Autopilot (level 3) ・Fully automated driving (level 4)	[Public-private (SIP[1])] Field operational Tokyo waterfront area Transport infrastructure development for field operational testing Develop for commercialization	Commercialize semi-autopilot Commercialize autopilot※	Develop market and further upgrade Develop market and further upgrade Initiatives for commercialization			Commercialize fully automated driving on expressways※	
	[Distribution services]	Truck platooning on expressways	Conduct demonstration testing of driver-assistive truck platooning Conduct demonstration testing of truck platooning with the trailing truck being unmanned	Realize technologies for truck platooning with the trailing truck being unmanned on expressways	Commercialize systems for truck platooning on expressways with the trailing vehicle being manned Expand the traveling distance and range	Develop services Commercialize systems for truck platooning with the trailing vehicle being unmanned on expressways		Develop services	
		Fully automated driving trucks on expressways (Level 4)						Achieve fully automated driving trucks on expressways※	
		Driverless automated driving delivery services in specified areas (level 4)		Apply technologies	Achieve driverless automated driving delivery services in specified areas			Develop services	
	[Mobility services]	Driverless automated driving transport services in specified areas (level 4)	Field operational tests for social implementation, private-sector preparations for commercialization, etc.	Achieve driverless automated driving transport services in specified areas	Develop services and further upgrade			Achieve driverless automated driving transport services in areas nationwide	
		Automated driving buses on expressways (level 2 and above)	Develop for commercialization		Market automated driving buses on expressways			Develop market	
		Advanced Rapid Transit (ART)	Prepare for private-sector standardization	Commence operations	Expand applicable areas and deploy overseas				
Initiatives pertaining to the promotion of innovation	[Developing systems and increasing social receptivity]	Charter for improvement of legal system and environment for automated driving systems	Conduct detailed studies of legal systems and environment and make necessary revisions						
		Social acceptance, collaborative systems	Promote society-wide collaborative systems and ITS on a local basis. Investigate social acceptance and develop systems for popularization						
	[Data strategy and the application and utilization of traffic data]	Data strategy pertaining to automated driving	[Public-private (SIP[1])] Utilization of signal information, vehicle-to-infrastructure cooperation information, vehicle probe information, etc.						
		Application and utilization of traffic-related data	Develop data Sequentially open-up						
	[Promoting R&D, demonstration testing, and international standards and benchmarks]	Privacy and security	Develop systems and study the promotion of collaboration among industry, academia, and the government on matters of privacy and security.						
		・Promoting R&D and demonstration testing ・International ragulations, standards, and leadership	Conduct studies on the expansion of collaborative domains and promote demonstration testing for implementation. International leadership pertaining to ragulations and standards						

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Red: Items inclusive of SIP[1]-related R&D

[1]SIP: Strategic Innovation Promotion Program of the Council for Science, Technology and Innovation.

※Set as timing for nonbinding targets to be fulfilled by the government in order to facilitate commercialization by private-sector companies.

Roadmap pertaining to automated driving systems I: Private automated driving vehicles (1)

FY	Short-term		Mid-term			Long-term	
	2019	2020	2021	2022	2023	2024～25	2026 ～ 30
[Private motor vehicles]							
Driving safety support vehicle	[Relevant ministries] Promote public awareness of driving safety support vehicles (Support Car S, Support Car)						
Driving safety support systems	[Private sector] Promote R&D and implementation		Commercialize advanced driving safety support systems		[Private sector] Develop market and further upgrade		
Automated driving on ordinary roads (level 2)	[Private sector] Promote R&D and implementation	Commercialize automated driving on ordinary roads	[Private sector] Develop market and further upgrade				
	[Public-private (SIP[1])] Field operational tests in the Tokyo waterfront area (Utilization of signal information, private-sector probe information, etc.)						
	Infrastructure development for field operational testing						
Automated driving on expressways ・Semi-autopilot (level 2)	[Private sector] Promote R&D and implementation	Commercialize semi-autopilot functionality	[Private sector] Develop market and further upgrade				
・Autopilot (level 3)	[Private sector] Promote R&D and implementation	Commercialize autopilot functionality※	[Private sector] Develop market and further upgrade				
・Fully automated driving (level 4)	[Relevant ministries] Conduct detailed studies of systems and make necessary revisions to systems						
	[MLIT] Conduct studies on schemes for sharing information from road-side sources at converging sections on expressways and elsewhere					Commercialize fully automated driving on expressways※	
	[Private sector] Promote R&D and implementation						

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Significantly reduce traffic accidents, ease congestion, streamline traffic for distribution, support mobility for the elderly and others

※Set as timing for nonbinding targets to be fulfilled by the government in order to facilitate commercialization by private-sector companies.

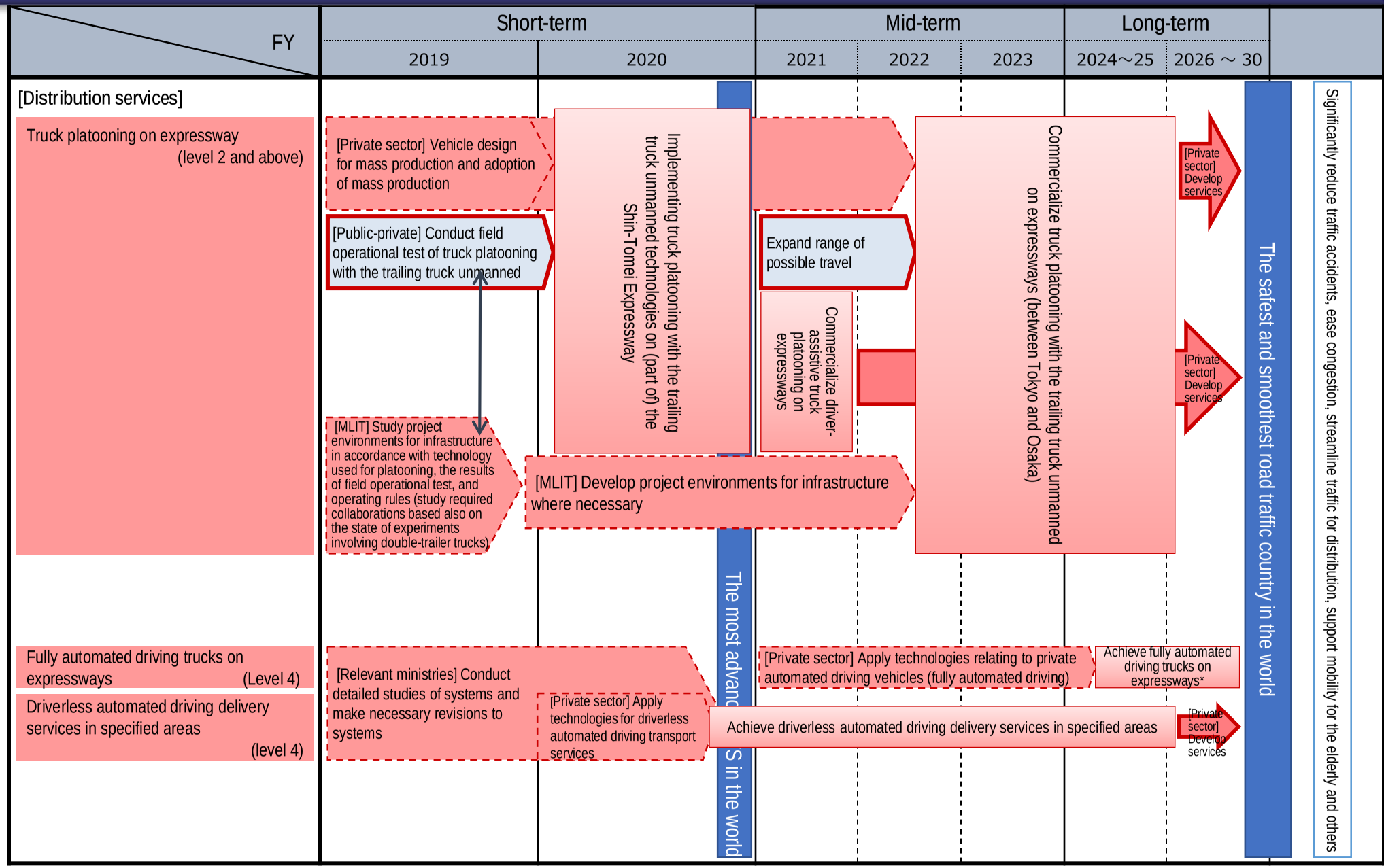
[1]SIP: Strategic Innovation Promotion Program of the Council for Science, Technology and Innovation.

Roadmap pertaining to automated driving systems I: Private automated driving vehicles (2)

FY	Short-term		Mid-term			Long-term		
	2019	2020	2021	2022	2023	2024～25	2026 ～ 30	
[Promote the popularization of safe driving support systems] • Driving safety support system (DSSS) • ETC2.0 • Measures to prevent driving in the wrong direction on expressways • Emergency driving stop system and other initiatives	[Public-private] Promote the popularization of DSSS- and ETC2.0-compatible onboard equipment [NPA (SIP[1])] Streamline the collection and provision of traffic control information [MLIT] Initiatives to achieve smooth, safe, secure road traffic based on the use of ITS technologies; expand the use of ETC and other ITS technologies for private-sector parking lots and other non-expressway facilities [MLIT] For measures to prevent driving in the wrong direction on expressways, more effective measures – including rapid detection of vehicles being driving in the wrong direction, road and in-vehicle warnings, and the use of automated driving technologies – shall be studied through a collaboration among industry, government, and academia [MLIT] Conduct studies on the expansion and fortification of security benchmarks concerning commercialized highly advanced safety technologies [MLIT] Evaluate vehicles with onboard advanced safety technologies through motor vehicle assessments Evaluate advanced emergency braking systems (for vehicles and for pedestrians) [MLIT] Formulate a technical policy for shoulder stoppage-type emergency driving stop systems	The safest road traffic country in the world					The safest and smoothest road traffic country in the world	Significantly reduce traffic accidents, ease congestion, streamline traffic for distribution, support mobility for the elderly and others
• Emergency call system and automatic collision notifications system (ACN) • Drive recorder, event data recorder	[Public-private] Promote the popularization of an emergency call system and automatic collision notification system (ACN) [MLIT] Ascertain accident conditions and analyze information using drive recorders and event data recorders * Ended in FY2018 [Public-private] Field operational testing of systems such as those utilizing telecommunications between vehicles on the road in (SIP[1]) development and testing, systems utilizing infrastructure radar and wireless telecommunications, systems to support traffic controllers and pedestrians, etc. [Private sector] Market deployment of sensors and terminals							

[1]SIP: Strategic Innovation Promotion Program of the Council for Science, Technology and Innovation.
[2] Measures pertaining to safe driving support and automated driving systems

Roadmap pertaining to automated driving systems I: Logistics services



* Set as timing for nonbinding targets to be fulfilled by the government in order to facilitate commercialization by private-sector companies.

Roadmap pertaining to automated driving systems I: Mobility services

FY	Short-term		Mid-term			Long-term	
	2019	2020	2021	2022	2023	2024～25	2026 ～ 30
[Mobility services]							
Driverless automated driving transport services in specified areas (Level 4 and others) • Remotely controllable automated driving systems • Last-mile automated driving (dedicated space)※1 • Rural areas (Roadside stations in intermediate and mountainous areas)	[Private sector] Expand and improve locally-aligned systems and establish systems for collaborating with local governments [Private sector] Manufacture locally-aligned vehicles [METI, MLIT] Conduct demonstration testing in model areas and verify social acceptance [MLIT (incl. SIP[1])] Rural areas (Roadside stations) Field operational testing in preparation for social implementation, study of diverse business models utilizing regional characteristics [Private sector] Conduct demonstration testing in local areas [Relevant ministries] Detailed study of systems, required system revisions	Achieve driverless automated driving transport services in specified areas	[Private sector] Develop and further upgrade services (such as by expanding service areas and upgrading service contents)			Achieve driverless automated driving transport services in areas nationwide	
Automated driving of buses on expressways (level 2 and more)	[Private sector] Promote R&D and implementation				Market automated driving buses on expressways		[Private sector] Develop market
Next-generation urban traffic system (ART)		Commence Tokyo BRT operations[2]	[Private sector] Develop services				
Automated valet parking※1	[Private sector] Field operational testing in preparation for practical implementation	[Private sector] Develop dedicated parking lots and more					

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Significantly reduce traffic accidents, ease congestion, streamline traffic for distribution, support mobility for the elderly and others

※1: Studies to be undertaken from systemic and infrastructural perspectives will be separately required.
[1]SIP: Strategic Innovation Promotion Program of the Council for Science, Technology and Innovation.

※2: Gradually commence traveling operations in line with the status of the development of the Loop Road No. 2 project

※Set as timing for nonbinding targets to be fulfilled by the government in order to facilitate commercialization by private-sector companies.

Roadmap pertaining to the promotion of innovation I: Development of institutions toward the popularization of automated driving and enhancement of social receptivity

FY	Short-term 2019	Short-term 2020	Mid-term 2021	Mid-term 2022	Mid-term 2023	Long-term 2024～25	Long-term 2026 ～ 30	
[Improvement of legal systems]								
Improvement of legal system and environment for automated driving systems	[National Police Agency, Ministry of Foreign Affairs] Organization of matters related to the Convention on Road Traffic (Geneva Convention)							
	[MLIT] Submittal to the Diet of a bill to revise part of the Road Transport Vehicle Act → Passage → [MLIT] Preparations for enactment → Enactment*							
	[NPA] Submittal to the Diet of a bill to revise part of the Road Traffic Act → Passage → [NPA] Preparations for enactment → Enactment							
	[MLIT] Formulation and adoption of international regulations in safety regulations (advanced emergency braking systems)							
	[MLIT] Formulation of international regulations in security regulations (cybersecurity)							
	[MLIT] Formulation of international regulations in security regulations (automated lane keeping systems on expressways [Level 3])							
	[MLIT] Formulation of (tentative) guidelines for driver absence							
[Social acceptance and developing collaborative systems]								
Societal acceptance • Dialog with citizens • Techniques for estimating effects in terms of reduced traffic accident fatalities	[Public-private (SIP[1])] Increase social acceptance ・Hold dialog sessions with citizens ・Impact assessment for purposes such as reducing traffic accidents ・Research on advanced drive-support systems for traffic controllers							
Collaborative systems for society in general and local areas	[Public-private] Promote collaborative systems for society in general and ITS on a local level							

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*Enactment of content on matters such as addition of automated-driving equipment to safety standards under the Road Transport Vehicle Law

[1]SIP: Strategic Innovation Promotion Program of the Council for Science, Technology and Innovation.

Roadmap pertaining to the promotion of innovation II: Data strategy pertaining to automated driving and applying and utilizing traffic data

FY: Short-term (2019, 2020); Mid-term (2021, 2022, 2023); Long-term (2024～25, 2026 ～ 30)

[Build a video database]

- Driving footage and other sensing data
- Accident data
- Safety-evaluation scenarios

[Private sector] Develop an environment for evaluating recognition technologies

[Private sector] Operate

[Private sector] Disclose and operate (driving footage and other sensing data)

[Private sector] Disclose and operate (accident data)

[METI, MLIT] Produce scenarios

[METI, MLIT] Investigate appropriate approach to sharing accident/incident data relating to scenarios

[Dynamic maps]

Implement and upgrade dynamic maps

[Private sector] Expand areas covered by dynamic maps and update maps

[Public-private (SIP[1])] High-precision 3D map updating technologies, architecture development, etc.

Commercialize semi-autopilot functionality

[Private sector] Expand areas covered by dynamic maps and update maps

[Sophistication of information and

- Implement fifth-generation mobile communications system (5G)
- Wireless communications systems underpinning a connected-car society

[MIC] Formulate a basic strategy to secure 5G frequencies, study technical conditions, conduct comprehensive demonstration testing premised on specific uses in the field of transportation, participate in activities to impose international standards, and develop an environment for the utilization of radio waves

Implementation of 5G

[MIC] Develop and test wireless communications systems underpinning the connected-car society

[Public-private (SIP[1])] Development of new technologies such as V2X telecommunication

Further popularize and upgrade

[Development and utilization of traffic-related data and automobile-related data]

- Conduct studies on the use of traffic data (probe information, hazard sites, and more)
- Study matters concerning the shared use of public-private data
- Upgrade public information systems
- Conduct studies on the effective use and disclosure of public data
- Automobile-related information
- Provide pedestrian support and collaborate with public transit organizations

Open up traffic data
(Sequentially open up disclosable data based on private-sector needs)

Sequentially utilize some useable data to support safe driving and for automated driving

[Cabinet Secretariat, relevant ministries and agencies, private sector] Study matters relating to the use of private-sector data and the shared use of public-private data

[MLIT] Develop initiatives for the smart use of roads through the integrated use of a wide range of detailed big data, including ETC2.0 speeds, routes, and time data

[MLIT] Utilize ETC 2.0 data to facilitate the introduction of travel management support services for trucks and other such vehicles and expressway bus location systems, the provision of information on whether passage is possible during disasters, and studies on measures to deal with congestion affecting local tourism

[Public-private (SIP1)] Development and field operational testing of technologies for providing signal information, consideration of generation, provision, etc. of lane-level road and traffic information utilizing probe data

[NPA, MIC, MLIT] Study the issues pertaining to the collection and distribution of data that could be useful for traffic safety measures, congestion measures, and disaster measures

Easing of congestion

[MLIT] Develop an environment for the application and use of automobile-related information

Introduce new services

[MLIT] Conduct studies on and promote the popularization of the use of information relating to human mobility (walking and public transit)

Introduce new services

[Privacy and security systems]

- Develop systems for studying personal data
- Develop systems, engage in R&D, and conduct demonstration testing pertaining to security

[Public-private] Conduct studies on the development and promotion of privacy and security systems

[Cabinet Office, MIC, METI (SIP[1])] Engage in R&D, conduct demonstration testing, and create international standard to ensure the reliability of security for communications and vehicular systems

[Private sector] Expand J-Auto-ISAC

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[1]SIP: Strategic Innovation Promotion Program of the Council for Science, Technology and Innovation. [2] Measures pertaining to safe driving support and automated driving systems and the application and use of traffic-related data

Roadmap pertaining to the promotion of innovation III:
Research and development concerning automated driving systems and promoting international benchmarks and standards

FY	Short-term		Mid-term			Long-term		
	2019	2020	2021	2022	2023	2024～25	2026 ～ 30	
[Promote R&D and field operational testing]								
R&D and field operational testing pertaining to automated driving systems	[Public-private collaborations] Establish a system of public-private collaborations [Public-private collaborations] Promote various types of field operational testing on public roads [Cabinet Office, related government agencies (SIP[1])] R&D by SIP[1], field operational testing in the Tokyo waterfront area, etc.							
Develop and popularize alert terminals based on vehicle-to-vehicle communications and vehicle-to-infrastructure communications	[Private sector] Market deployment of systems utilizing vehicle-to-infrastructure communications							
Safety-evaluation	[NPA] Sequentially introduce intersection priority passage systems for emergency vehicles and route buses [NPA] Deploy infrastructure at key intersections nationwide [METI] Establish evaluation techniques at automated driving evaluation sites [Public-private (SIP[1])] Development of a safety evaluation environment in virtual spaces							
[Regulations, standards, international collaborations, and the demonstration of leadership]								
Initiatives concerning regulations and standards	[NPA, MIC, METI, MLIT] Promote the adoption of international regulations and standards pertaining to automated driving							
Demonstrate international leadership	[Cabinet Office (SIP[1])] Hold international conferences							

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[1]SIP: Strategic Innovation Promotion Program of the Council for Science, Technology and Innovation.