Panel on Business Strategies for Automated Driving "Action Plan for Realizing Automated Driving" Report Outline Version2.0

March 30, 2018

Panel on Business Strategies for Automated Driving

1. Introduction

Panel on Business Strategies for Automated Driving（1）

- Established as a panel of the METI, Director-General of the Manufacturing Industries Bureau and the MLIT, Director-General of the Road Transport Bureau in February 2015
- The panel studied necessary actions in "all-Japan" industry-academia-government collaboration so that the Japanese automobile industry can lead the world in the field of Automated Driving where growth is expected and contribute to resolving social problems such as traffic accidents.
- In FY 2015 and FY2016, the panel held discussions on [1] clarifying the ideal future vision of Automated Driving (Levels 2, 3 and 4) for general cars, [2] identifying areas requiring cooperative initiatives, [3] developing an institutional system to strategically respond to the creation of international rules (criteria and standards), and [4] promoting industry-academia collaboration, and publicized a report titled "Action Plan for Realizing Automated Driving" (March 2017).
- In FY2017, the panel promoted actions based on the schedules of progress determined in the "Action Plan for Realizing Automated Driving" and managed progress thereof, and started studying safety evaluation methods based on the results of research and development made so far.

Definition of Automated Driving Level (TP-18004 (issued on February 1, 2018))

Level	Outline	Monitoring and responding entity concerning safe driving
Human driver monitors all or partial aspects of the driving task.		
Level 0 No Automation	• Full-time performance by the human driver of all aspects of driving task	Human driver
Level 1 Driver Assistance	• Execution by a driver assistance system of subtasks of the driving task concerning either steering or acceleration/deceleration	Human driver
Level 2 Partial Automation	• Execution by a driver assistance system of subtasks of the driving task concerning both steering and acceleration/deceleration	Human driver
Automated driving system monitors all aspects of the driving task.		
Level 3 Conditional Automation	• Performance by an automated driving system of all aspects of the driving task (within limited areas*) • With the expectation that the human driver will respond appropriately to a request to intervene if it is difficult for the system to continue performing tasks	System (Human driver if it is difficult for the system to continue performing tasks)
Level 4 High Automation	• Performance by an automated driving system of all aspects of the driving task (within limited areas*) • Even if it is difficult for the system to continue the performance, the user is not expected to respond	System
Level 5 Full Automation	• Performance by an automated driving system of all aspects of the driving task (not within limited areas*) • Even if it is difficult for the system to continue the performance, the user*2 is not expected to respond	System

* The term "area" here is not necessarily limited to a geographical area but includes environments, traffic conditions, speed, temporal conditions, etc.

*2 The term "user" used here is based on the definition of SAE International J3016 (2016), which includes the driver.

1. Introduction

Panel on Business Strategies for Automated Driving（2）

List of panel members and study system

Panel members (Japanese syllabary order, honorifics omitted, underline: Chairman)

Tateo Arimoto	Professor, National Graduate Institute for Policy Studies (Sub program director, Strategic innovation creation program, Automated Driving system)
Takashi Odaira	Managing Executive Officer, Isuzu Motors Ltd.
Ryuji Omura	Managing Executive Officer, Renesas Electronics Corporation
Koichi Ogawa	Senior Researcher, Policy Alternatives Research Institute, The University of Tokyo
Yoichi Kato	Director, Managing Executive Officer, SUBARU Corporation
Yoshifumi Kato	Senior Managing Director, Denso Corporation
Minoru Kamata	Professor, Graduate School of Frontier Sciences, The University of Tokyo,
Terunao Kawai	Manager, Vehicles Research Department, National Traffic Safety and Environmental Laboratory, National Agency for Automobile and Land Transport Technology
Hidetoshi Kudo	Executive Officer, Mazda Motor Corporation
Ken Koibuchi	Executive General Manager, Advanced R&D and Engineering Company, Toyota Motor Corporation
Takashi Shigematsu	Chairman, Denso Ten Ltd.
Masahisa Shibata	Senior Managing Executive Officer, Panasonic Corporation
Kazuo Shimizu	International automobile journalist
Lei Zhou	Executive Officer, Partner, Deloitte Tohmatsu Consulting LLC
Yoshihiro Suda	Professor, Institute of Industrial Science, The University of Tokyo
Hiroaki Takada	Professor, Institutes of Innovation for Future Society / Graduate School of Informatics, Nagoya University
Masao Nagai	President, Japan Automobile Research Institute
Kunio Nakaguro	Managing Executive Officer, Nissan Motor Co., Ltd.
Shiro Nakano	Senior Fellow, JTEKT Corporation
Yoshiyuki Matsumoto	Director, Senior Managing Executive Officer, Honda Motor Co., Ltd.
Kimiya Yamaashi	Executive Officer CTO and Director of Technology Development Division, Hitachi Automotive Systems, Ltd.

Study system

Panel on Business Strategies for Automated Driving
Chairman: Minoru Kamata (The University of Tokyo)

Informal Follow-up Meeting

Chief Examiner:
Minoru Kamata
(The University of Tokyo)

Study Working Group on Safety Evaluation Environment

Chief Examiner:
Hiroshi Mori
(Tokyo University of Agriculture and Technology)

Deputy Chief Examiner:
Naoki Suganuma (Kanazawa University)

Observers

Japan Electronics and Information Technology Industries Association

Japan Automobile Manufacturers Association

Japan Auto Parts Industries Association

The General Insurance Association of Japan

JASPAR

The Society of Automotive Engineers of Japan

National Institute of Advanced Industrial Science and Technology

ITS Japan

Information-Technology Promotion Agency, Japan

Japan Automobile Importers Association

Secretariat

METI Manufacturing Industries Bureau

MLIT Road Transport Bureau

1. Introduction

Panel on Business Strategies for Automated Driving（3）

- The results of studies so far were compiled as the report titled "Action Plan for Realizing Automated Driving" (Version2.0).

※ This report (Version2.0) was compiled after studying technologies on the vehicle side and discussions with automobile manufacturers and suppliers. Therefore, considerations are separately required from the institution and infrastructure side.

Future Automated Driving (Levels 2, 3 and 4) of General Cars

- As a precondition of actions in cooperative areas, it is necessary to share the ideal future vision of Automated Driving.
- The future vision for these vehicles needs to be clarified separately for expressways and general roads, and for privately owned cars and business cars.

Strategic Separation of Competitive Areas from Cooperative Areas in Developing Automated Driving Technologies (Policies)

- Strategic cooperation is necessary because collaboration beyond the conventional framework is required for the practical use of Automated Driving.
- Actions have been actively promoted in Europe and the USA.

Demonstration Projects

- Projects on Automated Driving systems, which are expected to be completed between 2020 and 2030.
  (1) Vehicles Platooning (Driving in a Caravan)
  (2) Fully Automatic Parking
  (3) Last Mile Automated Driving System

Strategic Initiatives Concerning Rules (Criteria and Standards)

- Initiatives should be promoted utilizing the Institute for Automated and Connected Vehicle Standardization, Japan as a platform for collaboration concerning criteria (compulsory standards) and standards (voluntary standards).
- The Japan Automobile Manufacturers Association presented "strategic standardization areas and priorities". Efforts for securing resources, including personnel and capital, are being accelerated.

Promotion of Industry-Academia Collaboration

- It is necessary to promote collaboration with universities that have diverse human resources.
- Discussions were launched with the aim of developing a system in academia that will take charge of research in cooperative areas.
- With the aim of expanding the scale of joint research, the "Guidelines for Strengthening Joint Research in Industry-Academia-Government Collaboration" were presented.

2.Future Automated Driving (Levels 2, 3 and 4) of General Cars

(1) Ideal future vision of Automated Driving on expressways and general roads (Private use cars)

- On expressways, Level 2, which allows acceleration/deceleration and lane changing, will be realized by 2020 on the conditions that the driver monitors safe driving and can perform driving operation anytime. After 2020, advanced Automated Driving is expected to be realized.
- On public roads, Level 2 should be achieved for straight driving on national public roads and major local roads around 2020, and the reach and scope of Automated Driving should be increased (such as increasing number of roads on which self-driving is permitted and allowing turns) around 2025.

※ As to the feasibility and period of Level 3 and higher, further legal and technological discussions are required and the description was made as reference.

2020 2025

Expressways

1 Level 2
> The car can stay in its lane by recognizing the white lines and road signs, track the vehicle in front by recognizing surrounding vehicles and change lanes.
☐ The load can be reduced during driving.

2 Level 3
> The car can stay in its lane by recognizing the white lines and road signs, track the vehicle in front by recognizing surrounding vehicles and change lanes.
> The car can also merge with and exit the flow of traffic.
☐ The load can be reduced during driving.
☐ Secondary activity is partially enabled.

3 Level 4
☐ No load on the driver

Major trunk roads
(National public roads and major local roads)

4 Level 2 (Turns are not allowed)
> The car can stay in its lane by recognizing the white lines and road signs, track the vehicle in front by recognizing surrounding vehicles and change lanes. (White lines and road signs must be provided.)
> The car can go straight at intersections by recognizing traffic signals. (Turns and driving at intersections without traffic signals are not allowed.)
☐ The load can be reduced during traffic congestion.

4 + Allowing turns

5 Level 2
> The car can go straight at intersections by recognizing traffic signals. (Driving at intersections without traffic signals is not allowed.)
☐ The load can be reduced during driving.

4 + Automated Driving Level UP

5' Level 3 (Turns are not allowed)
☐ The load can be reduced during traffic congestion.
☐ Secondary activity is partially enabled.

5 + 5' + Allowing turns

6 Level 2
> The driver needs to respond during bad weather.
☐ The load can be reduced during driving.

6' Level 3
> The driver needs to respond during bad weather.
☐ The load can be reduced during driving.
☐ Secondary activity is partially enabled.

Other roads

5'' Level 2 (Turns are not allowed)
> The car can go straight on all roads including roads without white lines / road signs and go straight at intersections without traffic signals. (Turns are not allowed)
☐ The load can be reduced during driving.

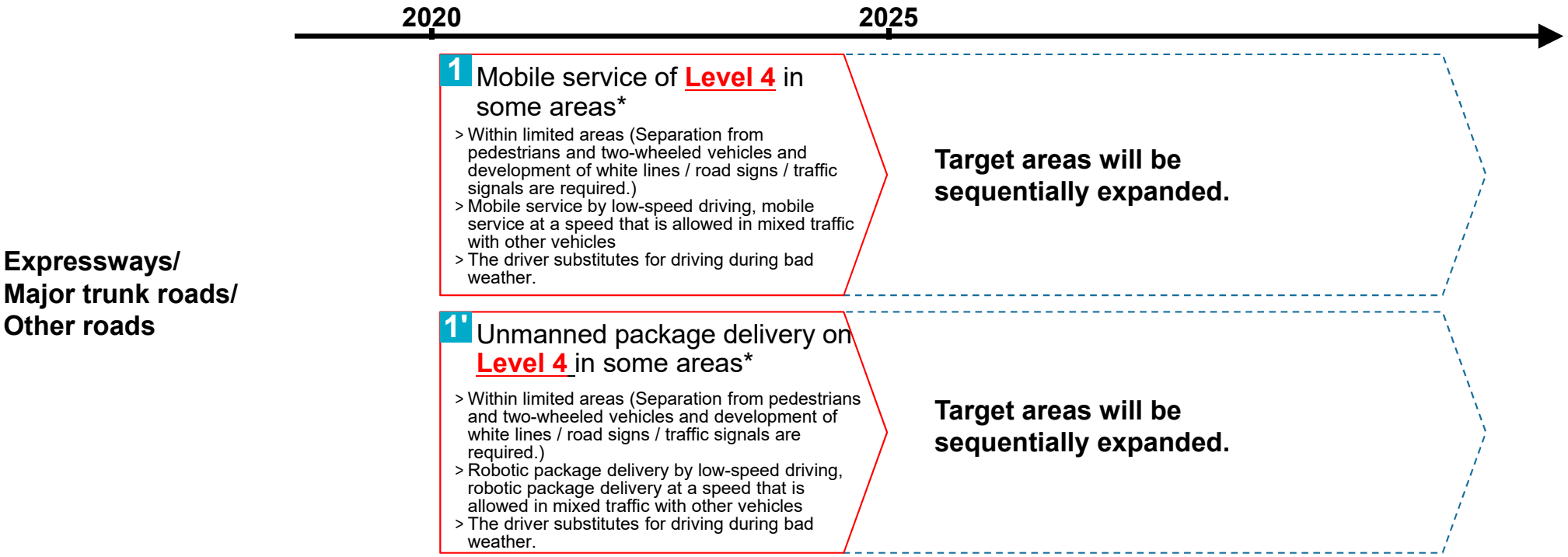
4 + Increase in the number of roads on which self-driving is permitted

5' + Allowing turns, Increase in the number of roads on which self-driving is permitted

2.Future Automated Driving (Levels 2, 3 and 4) of General Cars

(2) Ideal future vision of Automated Driving on expressways and general roads (Cars for Business Use (Mobile and Distribution Service))

- Around 2020, areas where there are large social needs and economic efficiency can be easily established are selected, and infrastructure required in the areas can be developed together with the establishment of a legal framework. Under such circumstances, Level 4 for business use will be realized in limited areas.
- The areas where Automated Driving services will be introduced is expected to increase with an expansion of the size and number of areas where Level 4 is enabled.
- For achieving Level 4, development should be promoted both in terms of "technologies" and "commercialization" while supplementing technologies with institutionalization and infrastructure, beginning with simple scenes and advancing to more complicated scenarios, with the aim of achieving the highest level in the world in this field.
- To that end, it is important how the performance on the vehicle side can exceed the complexity of the driving environment. Therefore, the complexity of the driving environment and the performance of hardware and software need to be categorized and indexed, and, based on their combination, the areas should be extracted and the necessary performance should be defined.



*Mobile services of Levels 2 and 3 and unmanned package delivery are expected to be realized.

3. Strategic Separation of Competitive Areas from Cooperative Areas in Developing Automated Driving (Policies)

- Necessary technologies are extracted for realizing Automated Driving (Levels 2 to Level 5).
- So that Japan is competitive in the future, 10 priorities are specified with the addition of "Safety evaluation" as the cooperative areas, by taking the areas that are difficult for companies to independently develop and implement in terms of resources and technology into consideration.
- Moreover, the panel extracted specific efforts where Japan should cooperate in the 10 priorities, largely from two categories - "Improving the efficiency of technological development" and "Fostering of clarification and acceptability of social values".

10 priorities

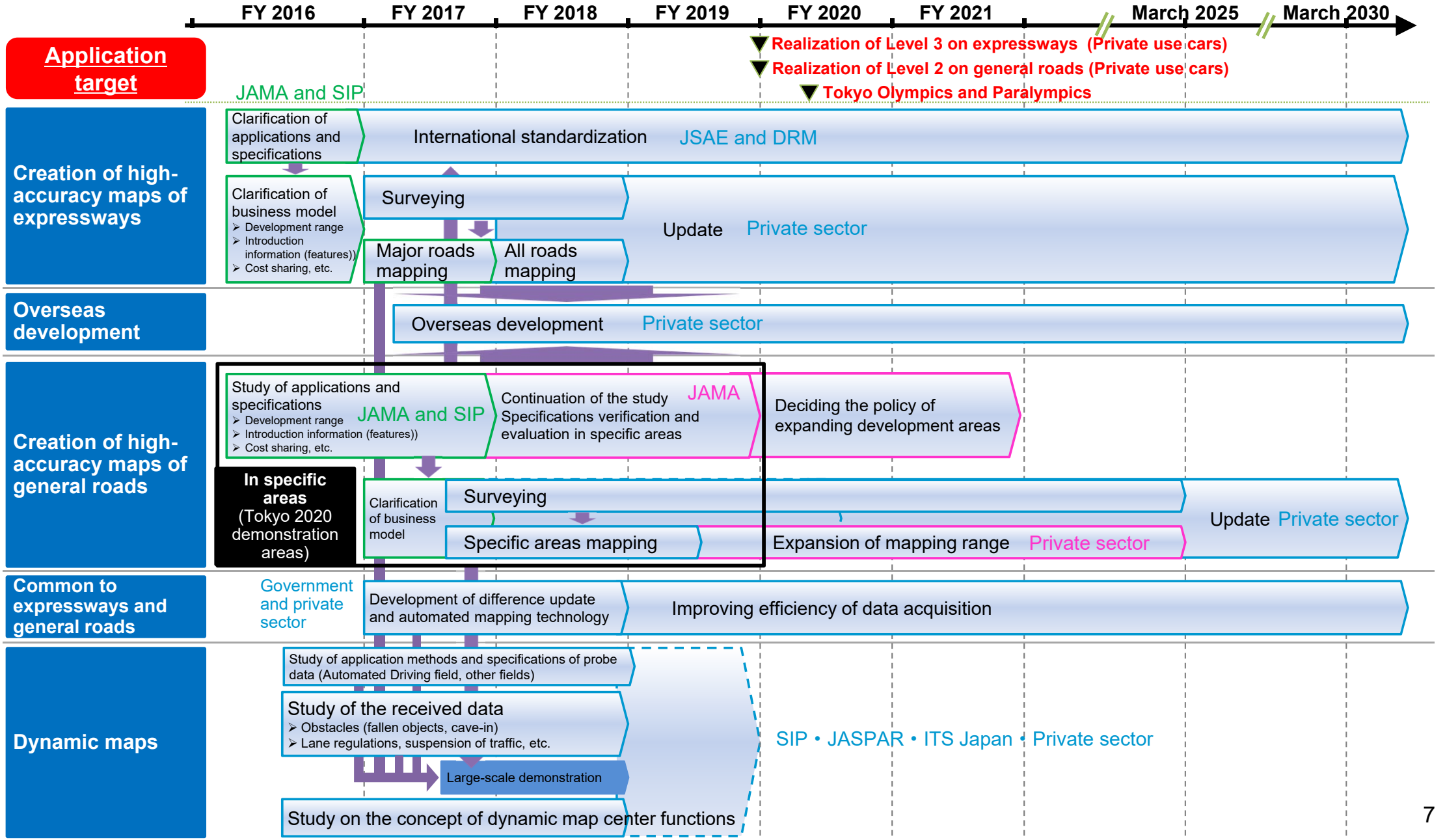
Cooperative Areas	Ideal future vision and policies
I. Maps	Aim at prompt development based on the marketing period of high-accuracy maps to enhance the performance of identifying the vehicle's position and recognition. **Presented the direction at the end of FY2017 for deciding the plan based on demonstrations on general roads in specific areas. Complete the specifications verification and evaluation in specific areas in FY2019 and decide the expansion plan into development areas by 2021.** Continue international development and cost reduction by automated mapping.
II. Information and communication infrastructure	To realize advanced Automated Driving at an early stage, aim to improve safety in coordination with information and communication infrastructure technologies in addition to autonomous automotive technologies. **Set cases of use and decide applicable infrastructure and demonstration sites in FY2017. It is necessary to set specifications and design requirements in FY2018 in cooperation with related organizations, and develop necessary infrastructure in specific areas and start demonstration tests at least within FY2019**.
III. Recognition technology IV. Path planning technology	It is necessary to sequentially establish minimum required performance criteria and their test methods in accordance with overseas trends. To improve development efficiency, aim at strategic cooperation in creating databases and providing test facilities and evaluation environments. **Promote the use of sensing, drive recorders, driving behavior and traffic accident data**.
V. Ergonomics	Aim at sharing development and evaluation infrastructure to improve development efficiency. **The identification of the driver's physiology and behavior indexes and the basic concept of the driver's monitoring system were completed in FY2017. Based on the verification of large-scale demonstration tests in FY2017 and FY2018, promote international standardization of various requirements in view of global development**.
VI. Safety	Aim at sharing development and evaluation methods to improve development efficiency for ensuring safety. **Formulated cases-of-use scenarios, derived sensor target performance and extracted design requirements, and these have been proposed to be considered as international standards in FY2017. Establish evaluation methods in the event of vehicle system failures, performance limits of sensors and misuse.**
VII. Cyber security	Aim at sharing development and evaluation methods to improve development efficiency for ensuring safety. **Set the minimum required standards and proposed such standards to be considered as international standards, and formulated the industry guideline in FY2017. Aim to put the evaluation environment (testbed) into practical use by FY2019. Strengthen the information-sharing system and study the cyber security framework**.
VIII. Human resources for software engineering	Aim to discover, secure and train human resources for software engineering including cyber security, which is the core of development, to resolve the shortage thereof. **Classified and arranged software skills and conducted a survey on the discovery, securing and training of human resources for software engineering in F2017. In FY2018, promote the formulation of skills standards. Provided courses on cyber security in FY2017. Study efforts of cooperation among the automobile industry in advertising the need of cyber security human resources and attractive features of their jobs in the future**.
IX. Social acceptance	Show the effects and risks of Automated Driving and promote development of the system according to people's needs with the aim of developing the environment required for societal implementation. For its realization, **present the effects of Automated Driving and define where the responsibilities lie, which is a precondition of the spread of Automated Driving, and continuously report on the state of things**.
X. Safety evaluation	**Aim to create safety evaluation technology that utilizes the technologies that have been developed through the Panel on Business Strategies for Automated Driving, etc. Create scenarios that show traffic environments in Japan in cooperation and use the scenarios for international discussions. Also, study the handling of data concerning accidents that will occur in the future and use the data for safety evaluations.**

I. Maps (High-accuracy 3D maps, dynamic maps)

Completion
Underway and policies
Underway and policies (New)

Ideal future vision and policies

- Aim at prompt development based on the marketing period of high-accuracy maps to enhance the performance for identifying the vehicle's position and recognition.
- Presented the direction at the end of FY2017 for deciding the plan based on demonstrations on general roads in specific areas. Complete the specifications verification and evaluation in specific areas in FY2019 and decide the expansion plan into development areas by 2021. Continue international development and cost reduction by automated mapping.



<Reference> I. Maps (High-accuracy 3D maps, dynamic maps)

- DMP, which generates, maintains and provides map data, was established for creating high-accuracy 3D maps (relative accuracy 25cm, equivalent to map information level 500).
- Dynamic maps are high-accuracy 3D maps that links dynamically changing information such as traffic regulation information, traffic congestion information and vehicle positions. To ensure business feasibility in the future, it is necessary to study a service platform for developing linked information to other fields outside of Automated Driving.

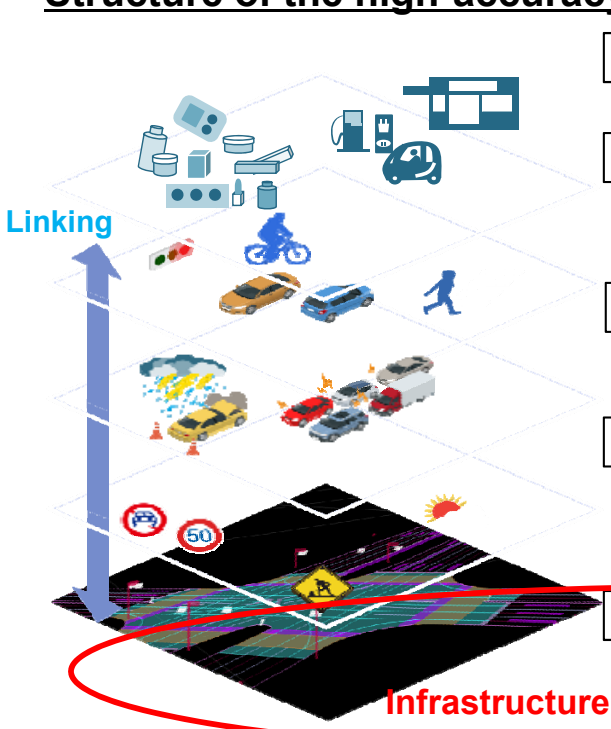
Dynamic Map Platform Co., Ltd.
President: Tsutomu Nakajima
Established: June 2016
(The description of their line of business was changed from a planning company to business company in June 2017.)

Funds: 産業革新機構

Mapping / Surveying companies: MITSUBISHI ELECTRIC, ZENRIN, PASCO, アイサンテクノロジー株式会社, mapmaster, Increment P

Automobile companies: NISSAN, TOYOTA, HONDA, HINO, SUZUKI, ISUZU, SUBARU, MITSUBISHI MOTORS, mazda, DAIHATSU

Structure of the high-accuracy 3D maps and dynamic maps



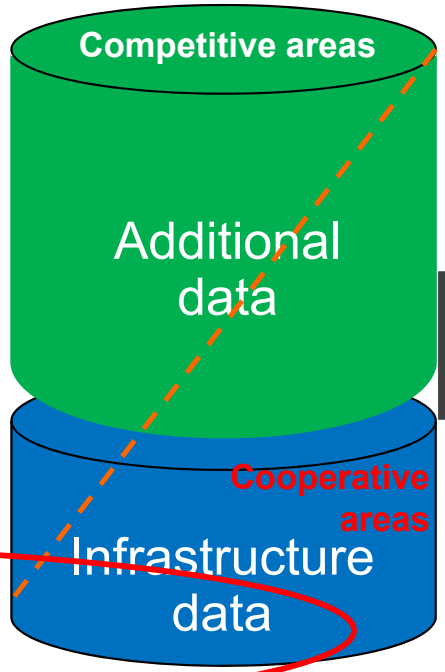
Additional information
- Purchase information, etc.

Dynamic information (<1sec)
- ITS read-ahead information (surrounding vehicles, pedestrian information, signaling information)

Quasi-dynamic information (<1min)
- Accident information, traffic congestion information, narrow-area meteorological information, etc.

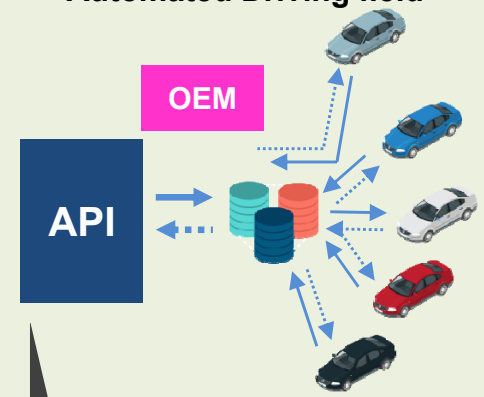
Quasi-static information (<1hour)
- Traffic regulation information, road construction schedule information, wide-area meteorological information, etc.

Static information (<1day)
- Road surface information, lane information, 3D structures, etc.



Dynamic map center

Developed to Automated Driving field

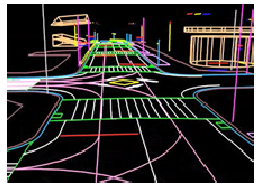


Developed to other fields

Surveying results

[Laser point group + Video data]

Mapping



II. Information and communication infrastructure

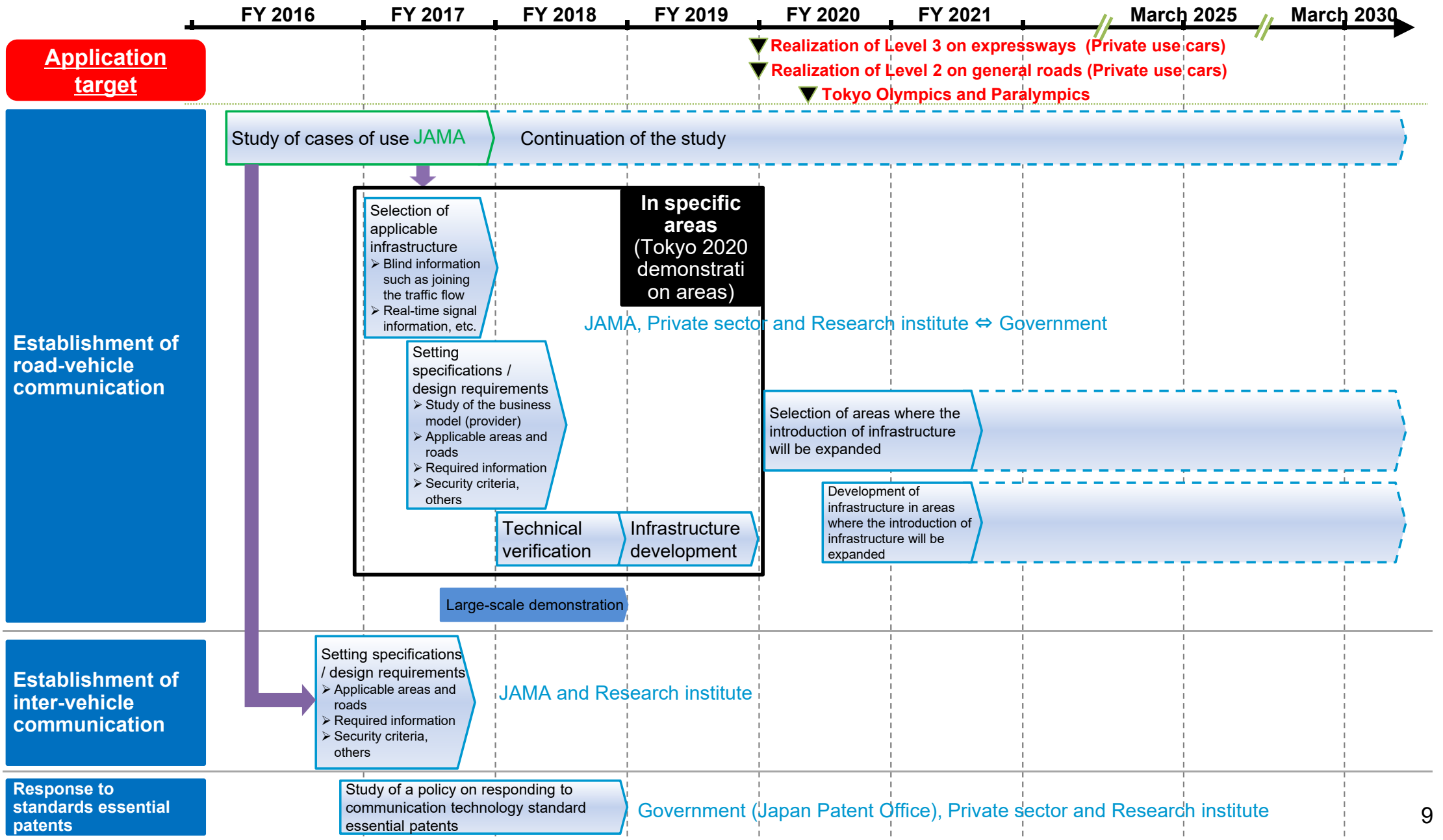
Completion

Underway and policies

Underway and policies (New)

Ideal future vision and policies

- To realize advanced Automated Driving at an early stage, aim to improve safety in coordination with information and communication infrastructure technologies in addition to autonomous automotive technologies.
- Set cases of use and decide applicable infrastructure and demonstration sites in FY2017. It is necessary to set specifications and design requirements in FY2018 in cooperation with related organizations, and develop necessary infrastructure in specific areas at least within FY2019.



<Reference>II. Information and communication infrastructure [1]

- Inter-vehicle and road-vehicle communication technology that realizes a driver support system using ITS-dedicated frequency has been developed.
- It is necessary to decide target infrastructure and areas concerning road-vehicle communication centering on general roads by considering the user of 5G communication technology in addition to ITS-dedicated frequency.

Inter-Vehicle and road-vehicle communication system image

Road-Vehicle communication

Purposes: Safe driving assistance, smooth driving, etc.

- **The system assists the driver's driving and controls the vehicle in advanced Automated Driving by having the vehicle obtain information (road traffic information) from infrastructure via radio communication between the vehicle and infrastructure facilities (roadside devices, etc.).**
- **Since it is difficult to promote the development of infrastructure facilities all at once, it is possible that the introduction of the system will be limited to service in specific places.**

(Example of use)

Red signal reminder
Call the driver's attention if, for example, the driver overlooks a red signal by continuing to press the accelerator pedal even if the vehicle is getting closer to the intersection with the red signal (system-supported signal).

Start preparation guide when waiting at a signal
Indicates the target for waiting at a red signal when the vehicle has stopped at red signal (system-supported signal)

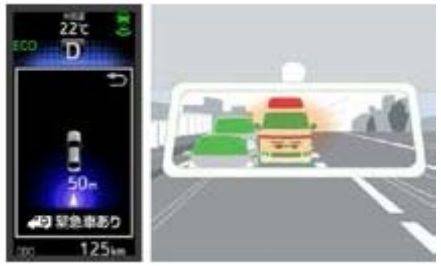
Turning right reminder
Call the driver's attention if, for example, the driver overlooks a straight-traveling vehicle in the opposing lane or a pedestrian on the right side of an intersection by trying to start the vehicle when the vehicle is stopped at the intersection (system-supported signal) before turning right.

Inter-Vehicle communication

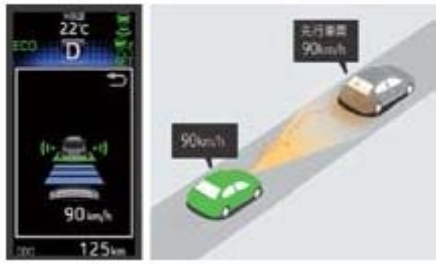
Purposes: Safe driving assistance, etc.

- **The system assists the driver's driving and controls the vehicle in advanced Automated Driving by having the vehicle obtain information of surrounding vehicles (positions, speed, vehicle control information, etc.) via radio communication between the vehicles.**
- **The opportunities for providing the service will be limited unless the installation of in-vehicle devices progresses.**

(Example of use)



Notice of emergency vehicle presence
Indicates the emergency vehicle's approximate direction and distance to one's own car if the emergency vehicle (system-supported vehicle) is nearby.



Communication type radar cruise control
If the lead vehicle is a corresponding vehicle, realizes smooth tracking-driving by restraining the change in inter-vehicular distance and speed based on acceleration and deceleration information of the lead vehicle.

※ Created based on Toyota Motor Corporation's website

<Reference>II. Information and communication infrastructure [2]

- The industry needs to decide cases of use (road-vehicle, inter-vehicle) as early as possible and automobile OEM companies need to internationally discuss the estimated communication volume, communication frequency and types of information (including importance) so that these requirements are appropriately input in to discussions concerning the ITS system (DSRC) and cellular system.

International discussions about radio communication technology

	ITS system			Cellular system	
	DSRC, etc. Already standardized			LTE-V2X 2018	5G-V2X 2020
	～6 GHz				
Study of concept and cases of use by application	SAE	C2C-CC	JAMA	5GPPP 2015/10/20 White paper 5G Automotive Vision	5GAA 2016/11/23 White paper The case for Cellular V2X for Safety and Cooperative Driving
Creation of a draft for formulating communication requirements	Private companies and organizations			Private companies and organizations	
Creating themes by international standards and forums	ITU	ETSI	ISO System architecture	SAE	IEEE IEEE 802.11p DSRC
Message standards protocol	ITU	ETSI TS 103097	IEEE IEEE 1609.2	USDOT CAMP	
Security requirements (signature verification, etc.)					
Demonstration tests (interconnectivity, performance requirements verification, etc.)	Large-scale demonstration test (SIP) CV pilot (U.S.) SCOOP@F (France) C-ITS corridor (Netherlands, Germany and Austria)				

It is important that automobile OEM companies cooperate in international decisions on:

- estimated communication volume,
- communication frequency,
- and types of information (including importance)

and needs to appropriately input such requirements into discussions about communication.

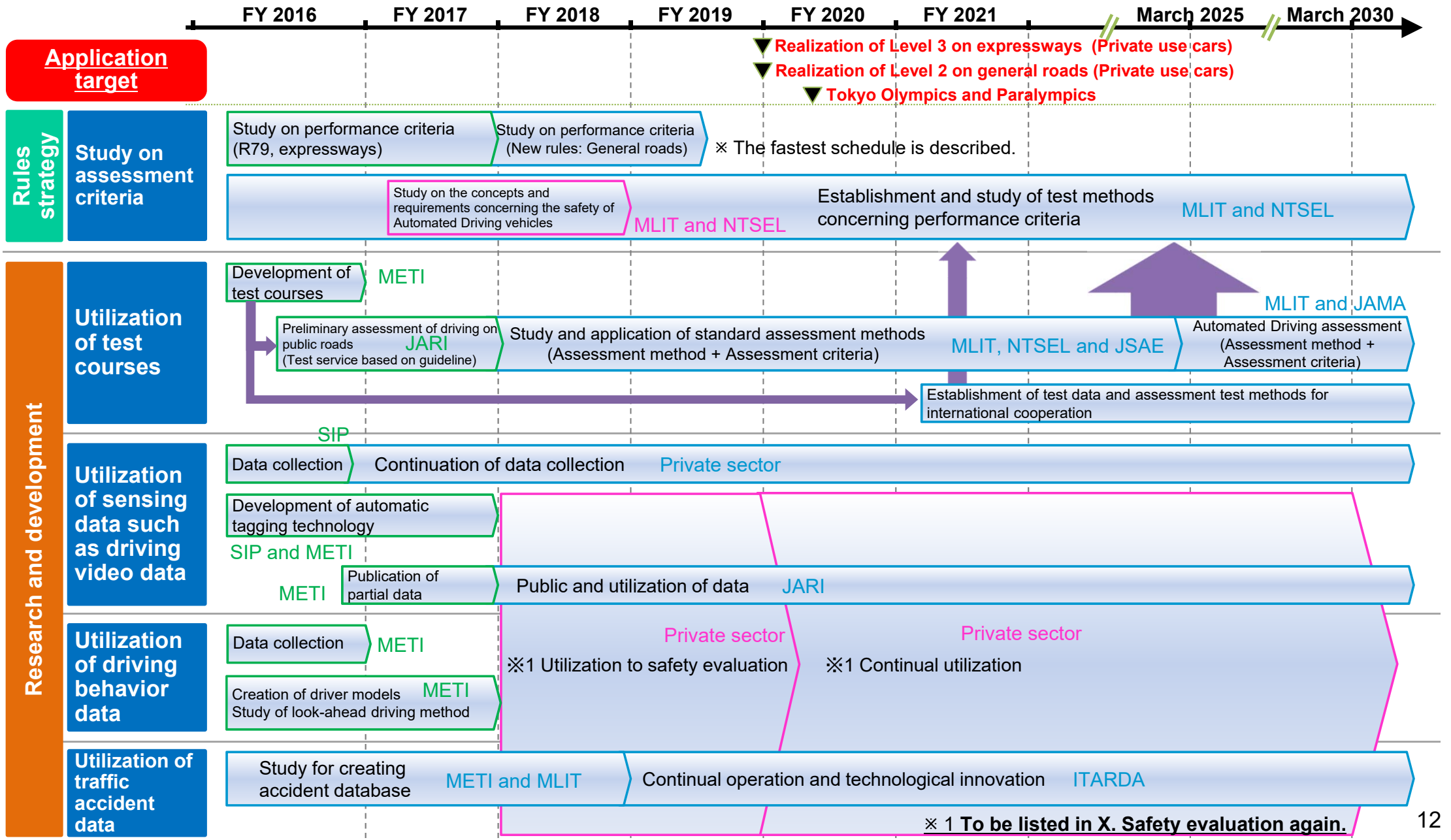
Promote the study including application to Automated Driving demonstrations in limited areas

III. Recognition technology, IV. Path planning technology

Completion
Underway and policies
Underway and policies (New)

Ideal future vision and policies

- It is necessary to sequentially establish minimum required performance criteria and their test methods in accordance with overseas trends.
- To improve development efficiency, aim at strategic cooperation in creating databases and establishing test facilities and evaluation environments.
- Promote the use of sensing, drive recorders, driving behavior and traffic accident data.



<Reference>III. Recognition technology, IV. Path planning technology [1]

- The system substitutes the driver with recognition and path planning in Automated Driving.
- Globally, the conventional development and evaluation system using actual vehicles is changing to a model base (virtual), and the collection of data that becomes the underlying basis of the modeling is an issue.
- Therefore, it is extremely important for companies to cooperate in collecting the data, extracting scenarios and conducting research and development of simulation technology so that they can individually perform development and evaluation.

[Task for sharing data]

- ☐ It is difficult for each company to acquire data it needs on its own.

↓

- ☐ Tasks when sharing data possessed by each company

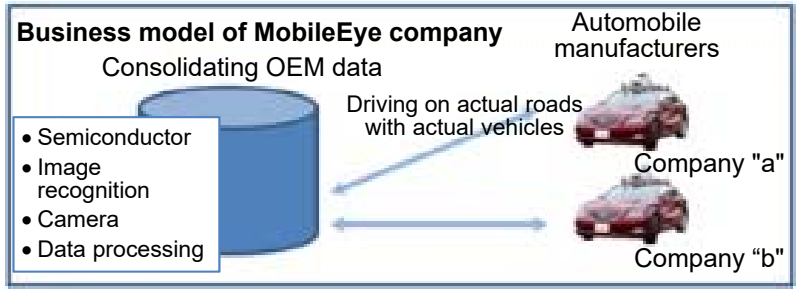
[Examples]

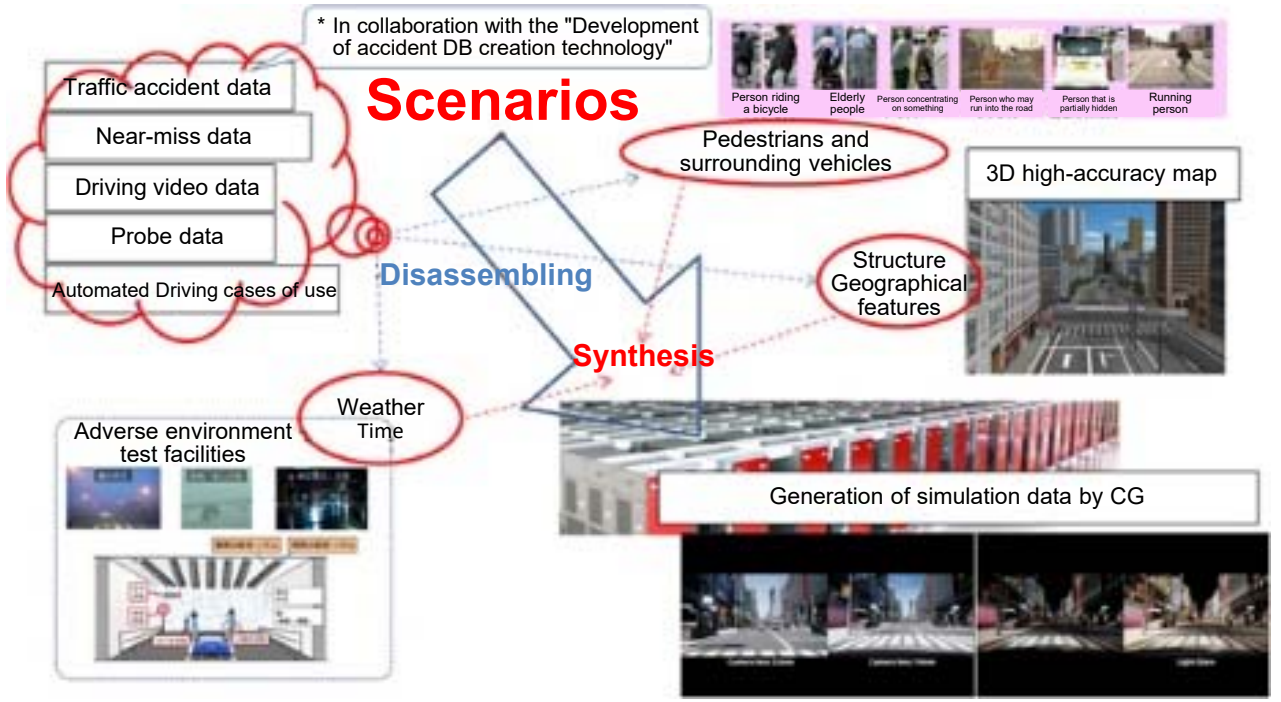
- Extracted minimum required information (scenarios etc.) from actually recorded data (raw) according to purposes.
- Created avatars of structures, vehicles, pedestrians, etc.
- Created a simulation environment with abstract models corresponding to purposes and evaluated it under assumed diversified conditions.

[Problem 1] Outflow of know-how to competitors

[Problem 2] Data of other suppliers and OEM companies cannot be used for reliability evaluations as they are because they are highly dependent on hardware such as camera installation position, lens and semiconductor.

[Problem 3]
It is impossible to actually record all assumed various states completely.

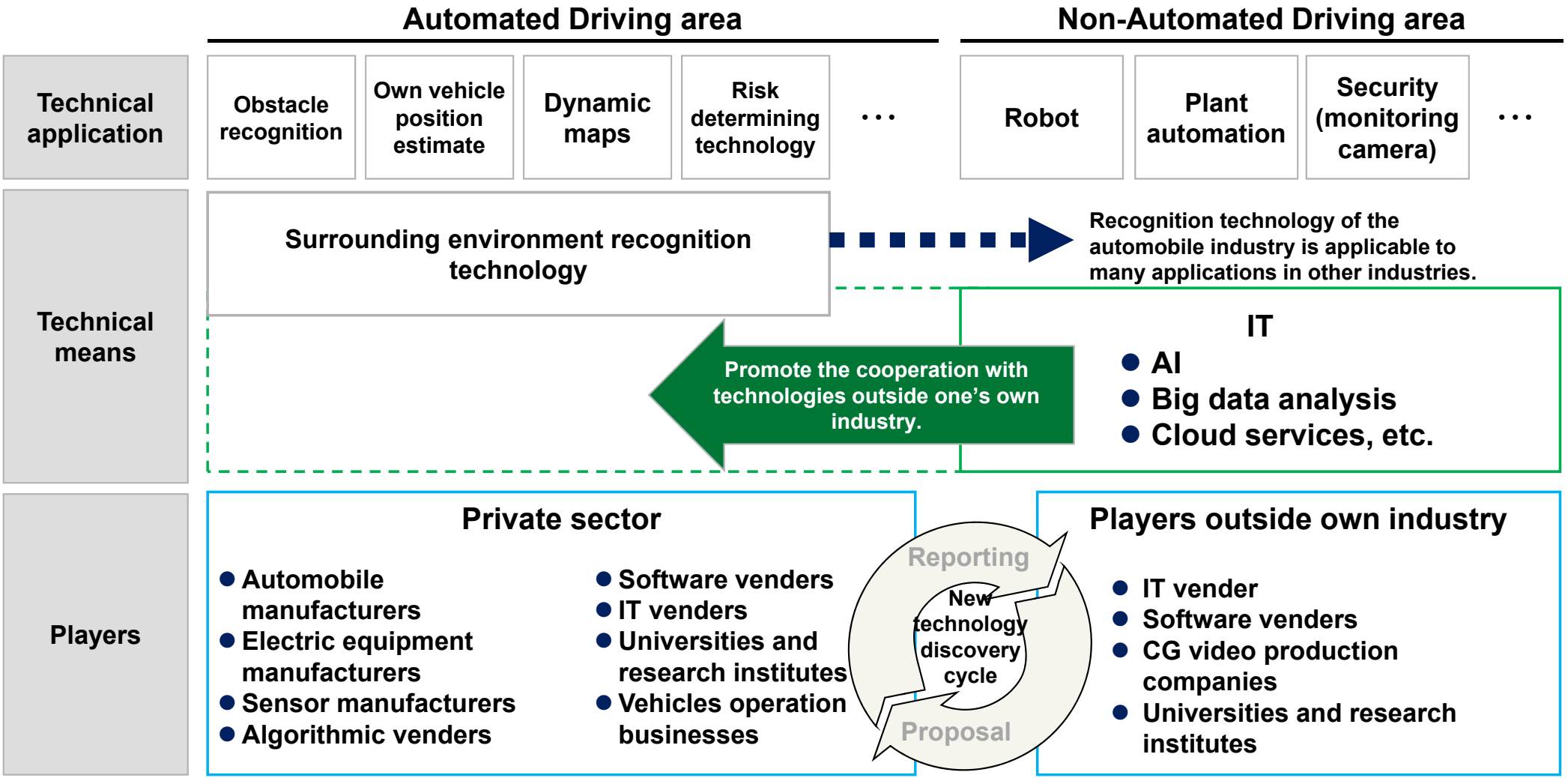




<Reference>III. Recognition technology, IV. Path planning technology [2]

- The surrounding environment recognition technology developed in Automated Driving areas can be applied to non-Automated Driving areas (for multipurpose use in other industries) in addition to Automated Driving areas. Therefore, it is important to study such application deployment and improve development in cooperation with other industries
- It is necessary to actively promote actions in cooperation with players in other industries without remaining only within one's own industry.

Image of cooperation with other industries to accelerate development



V. Ergonomics

Completion
Underway and policies
Underway and policies (New)

Ideal future vision and policies

- Aim at sharing development and evaluation infrastructure to improve development efficiency.
- The identification of the driver's physiology and behavior indexes and the basic concept of the driver's monitoring system were completed in FY2017. Based on the verification of large-scale demonstration tests in FY2017 and FY2018, promote international standardization of various requirements in view of global development.

FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020 | FY 2021 | March 2025 | March 2030

Application target

▼Realization of Level 3 on expressways (Private use cars)
▼Realization of Level 2 on general roads (Private use cars)
▼Tokyo Olympics and Paralympics

Rules strategy

International standards

- ISO TR21959 Part1 Note 1)
- ISO TR21959 Part2 Note 2)
- Response to revision of international standards — JSAE
- ISO TR23049 Note 3)
- Response to revision of international standards — JSAE

Research and development

Driver's readiness state※ and delegation of driving

- Identification of the driver's physiology and behavior indexes that allow a grasp of the readiness state of the driver
- Derivation of the relationship between the readiness state and the time required to transfer driving
- Study on various HMI that support the safe transfer of driving
- Study on the basic plan of a driver monitoring system
- Large-scale demonstration — SIP
- Study on readiness evaluation methods / basics requirements

System understanding

- Study on the methods for improving the driver's knowledge of the system and comprehension of the system's state

Interaction with other traffic participants

- Study on the method of communication between Automated Driving vehicles and surrounding traffic
- Large-scale demonstration — SIP

Secondary activity

- Study on the range of acceptable secondary activities
- Government ⇒ OEM companies

Note 1) Road Vehicles: Human Performance and State in the Context of Automated Driving: Part 1 – Terms and Definitions

Note 2) Road Vehicles: Human Performance and State in the Context of Automated Driving: Part 2 - Experimental guidance to investigate human takeover performance in the context of automated driving

Note 3) Road Vehicles – Ergonomic aspects of external visual communication from automated vehicles to other road users

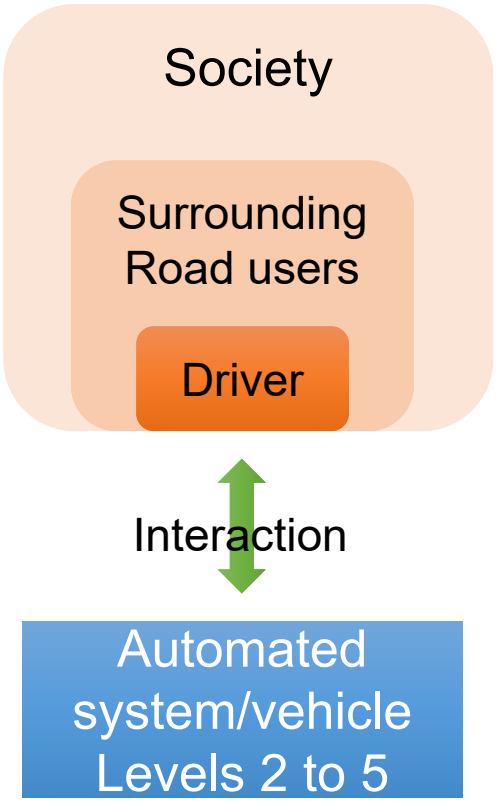
※) The Preparatory state where the driver receives driving tasks from the vehicle system are indexed.

<Reference> V. Ergonomics

- To develop the interaction between the Automated Driving system and human driver (inward HMI) and the interaction between the Automated Driving system and surrounding traffic participants (outward HMI), it is necessary [1] for the system to grasp the state of the human driver (readiness state) and for the human driver to understand the system functions and [2] to study how the behavior of the vehicle can be understood by other traffic.
- As for the driver behavioral indexes or basic plan of such study, it is necessary to take efficient actions in cooperation to improve the development efficiency.
- Moreover, it is important to conduct the study in anticipation of international standards to enhance the value as global products.

Overall picture of the tasks

The interaction between the Automated Driving system and human (driver, surrounding traffic participants and society) is a task that differs by the level of Automated Driving.



Ergonomics tasks map of Automated Driving

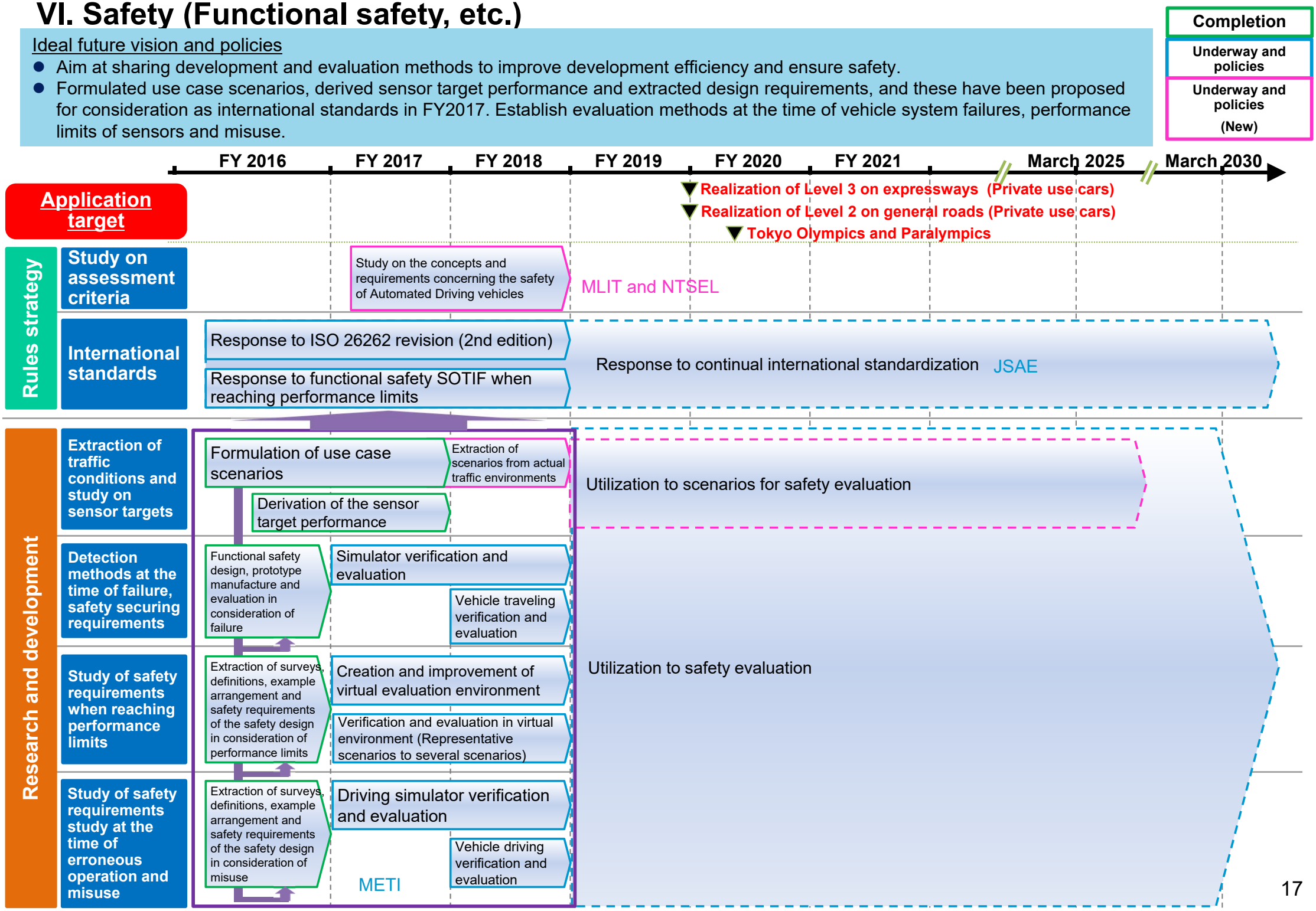
Interaction between vehicles and people			Automated Driving level				
			Level 1	Level 2	Level 3	Level 4	Level 5
Vehicle ⇔ Driver	Tasks concerning understanding of the system						
	A-1	Understanding of the system functions	Excessive dependence on system, overconfidence in the system functions, misunderstanding of the functions				
	A-2	Understanding the system state	Understanding the current state and future behavior of the system				
	A-3	Understanding system operation	Operating system usability (not understanding how to use the system or the meanings of operations)				
	A-4	Understanding system behavior	Uneasiness and discomfort toward different driving style than one's own (interruption by lane changing, deceleration on curves)				
	Tasks concerning the driver's state						
	B-1	Driver's state at the time of using the system		Appropriate driver's state and maintenance method			
	B-2	Transition from system to manual driving		Measures of safe driving handover			
	B-3	User value of the system		Creation of value that is superior to the urge to fall asleep	Creation of value that is superior to the interruption of relaxation	Creation of value that is superior to standardized driving	
Vehicle ⇔ Surrounding traffic participants	C-1	Communication between Automated Driving cars and surrounding drivers		Means of communication at intersections and when the vehicle merges with the traffic flow and changes lanes.			
	C-2	Communication with Automated Driving cars and pedestrians, etc.		Means of communication when pedestrians cross the road and in shopping areas and parking lots.			
	C-3	Balance between compliance with traffic rules and promoting smoother road traffic				Mutual concessions, discord between legal speed limit and traffic flow speed	
Vehicle ⇔ Society	D-1	Social values and acceptance of Automated Driving cars				Functional design corresponding to the diffusion ratio to enhance social acceptance	
	D-2	Where the responsibilities lie in the case of accidents and violation of traffic regulations				Responsibilities at the time of accidents and violation of traffic regulations during the use of the system	
	D-3	Driving license system				License system of Automated Driving cars	

Created by referring to SIP-adus Workshop 2015 materials

VI. Safety (Functional safety, etc.)

Ideal future vision and policies

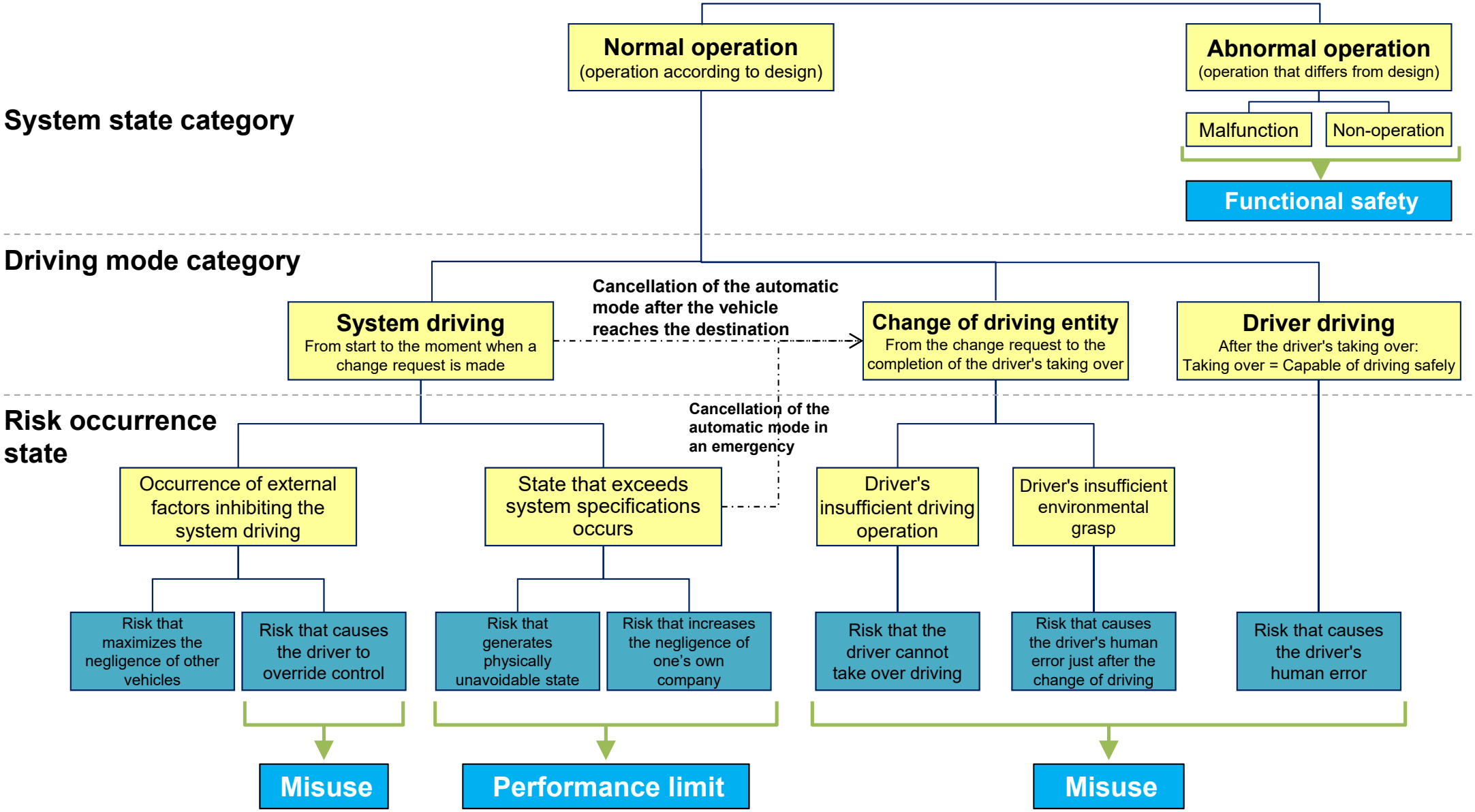
- Aim at sharing development and evaluation methods to improve development efficiency and ensure safety.
- Formulated use case scenarios, derived sensor target performance and extracted design requirements, and these have been proposed for consideration as international standards in FY2017. Establish evaluation methods at the time of vehicle system failures, performance limits of sensors and misuse.



<Reference> VI. Safety

- It is necessary to extract and classify risk occurrence state at the time of normal and abnormal operations of the Automated Driving system from the perspective of driving mode and establish development and assessment methods for safety design suitable for such categories.

Categories of risk occurrences in terms of safety during Automated Driving

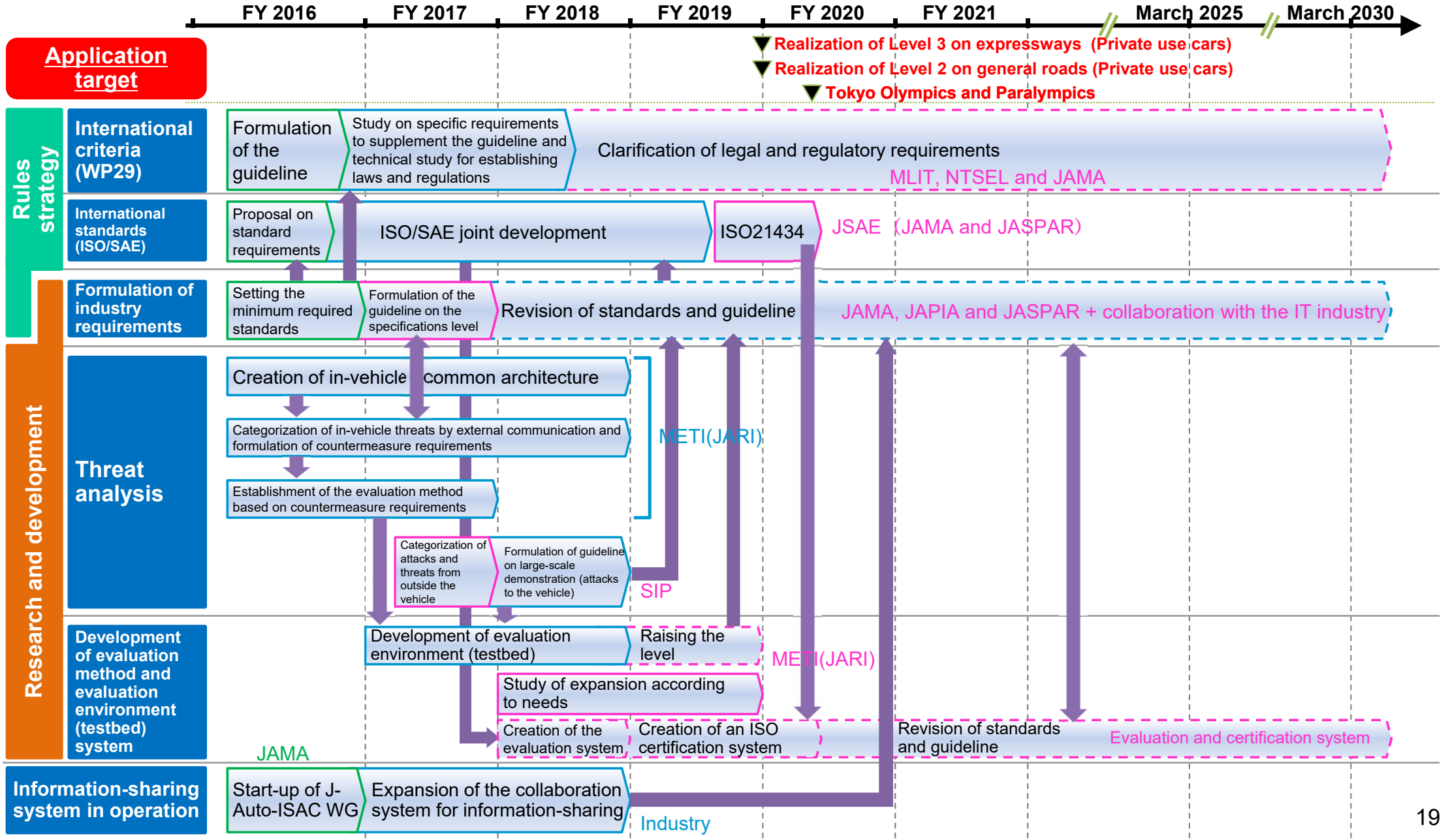


VII. Cyber security

Completion
Underway and policies
Underway and policies (New)

Ideal future vision and policies

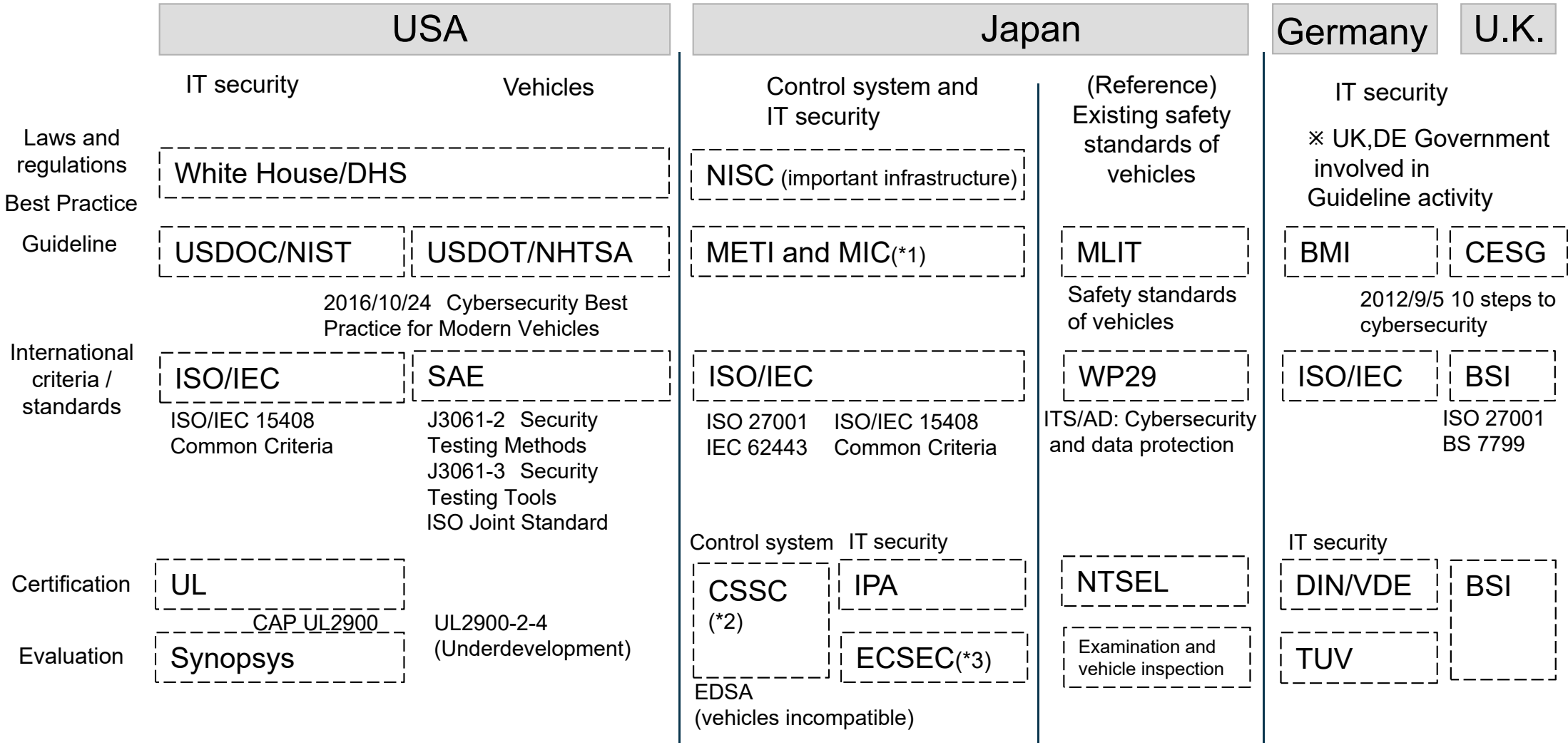
- Aim at sharing development and evaluation methods to improve development efficiency for ensuring safety.
- Set the minimum required standards and proposed such standards to be considered as international standards, and formulated the industry guideline in FY2017. Aim to put evaluation environments (testbed) into practical use by FY2019. Strengthen the information-sharing system and study the cyber security framework.



<Reference> VII. Security[1]

- The mainstream in security is that the Government proposes the policy, each industry decides the standards, and the private sector performs certification and evaluation.

Security international standards and their evaluation and certification system (arrangement of relationship)



(*1) Security Guideline 1.0 version for creating the safe driving assistance system in 700MHz band (MIC), July 9, 2015
(*2) Company licensed by the Minister of Economy Trade and Industry based on the Act on Facilitating Research and Development in Basic Technology
(*3) Company licensed by the Minister of Economy Trade and Industry based on the Act on Research and Development Partnership concerning Mining and Manufacturing Technology, Japan Information Technology Security Evaluation and Certification Scheme (JISEC)

<Reference> VII. Security [2]

- As for problems, there is no bare minimum in security standards that needs to be secured, and it is unclear to what extent the automobile industry should respond. It is required to supply products after securing the safety of Automated Driving and connected cars.
- After deciding the security target that should be secured, it is necessary to establish a system for promoting [1] evaluation standards, [2] research on the latest vulnerabilities, and [3] human resources development, and form a view as to what extent the resources should be supplied by individual companies.

Image of industry-academia-government division of roles for vehicle security

[1] Setting the bare minimum in standards that should be secured in the industry

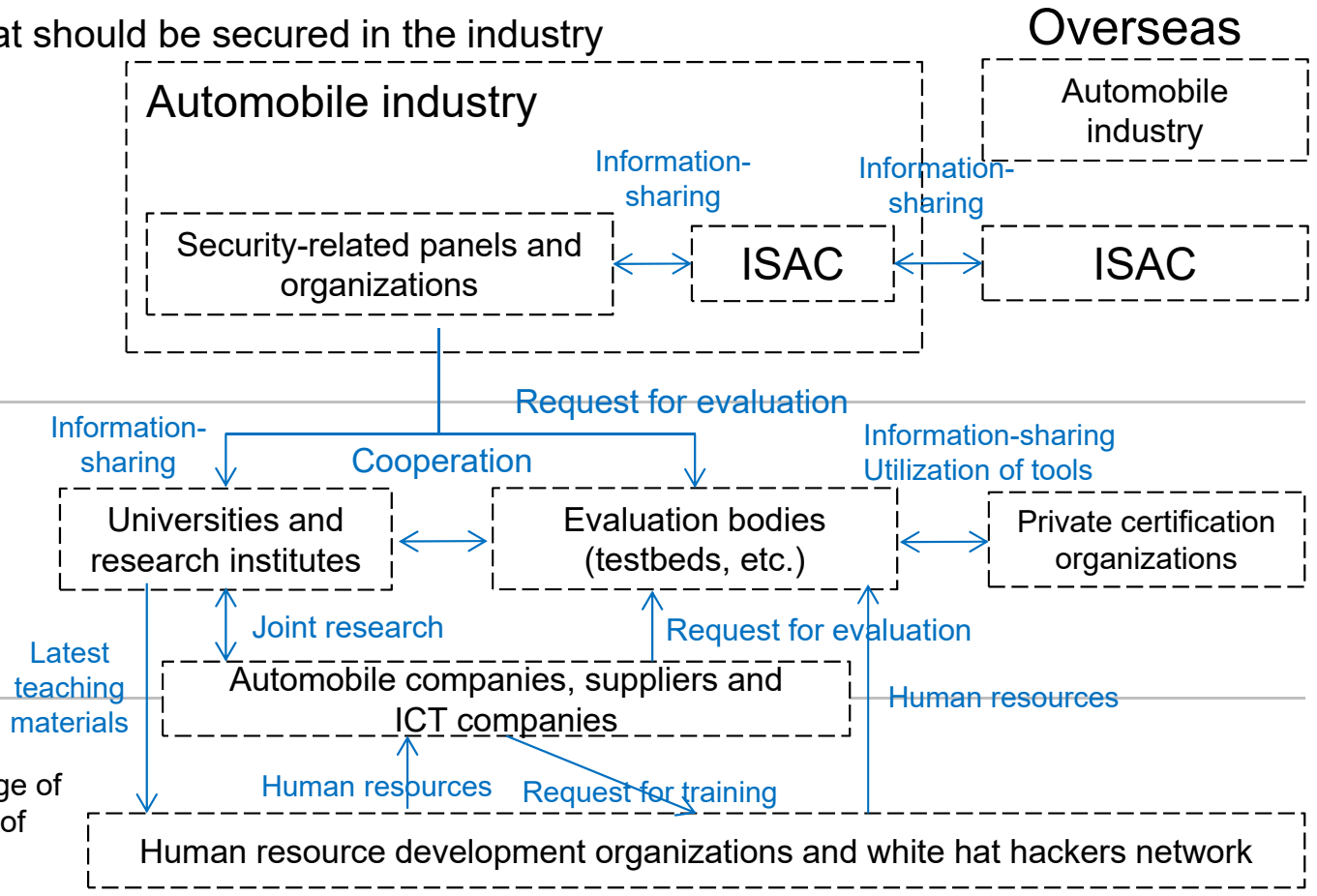
- Responsibility lying with the entity that has set the target values (assessment criteria)
- Clarification of the purposes for certification and evaluation
  → Decide the bare minimum in standards that should be secured and clarify the necessary technology and personnel resources.
- Companies compete with each other as to measures that exceed the decided standards.

[2] Research on the latest vulnerability

- Some problems cannot be covered by existing and new evaluation tools while a threat is evolving.
  → Continual study on latest vulnerabilities
  → Efficient information-sharing system

[3] Human resources development

- Raising the skill level of companies' persons in charge of product development and evaluation, and formation of the network with white hat hackers
  → Human resources who can contribute to security measures as public property

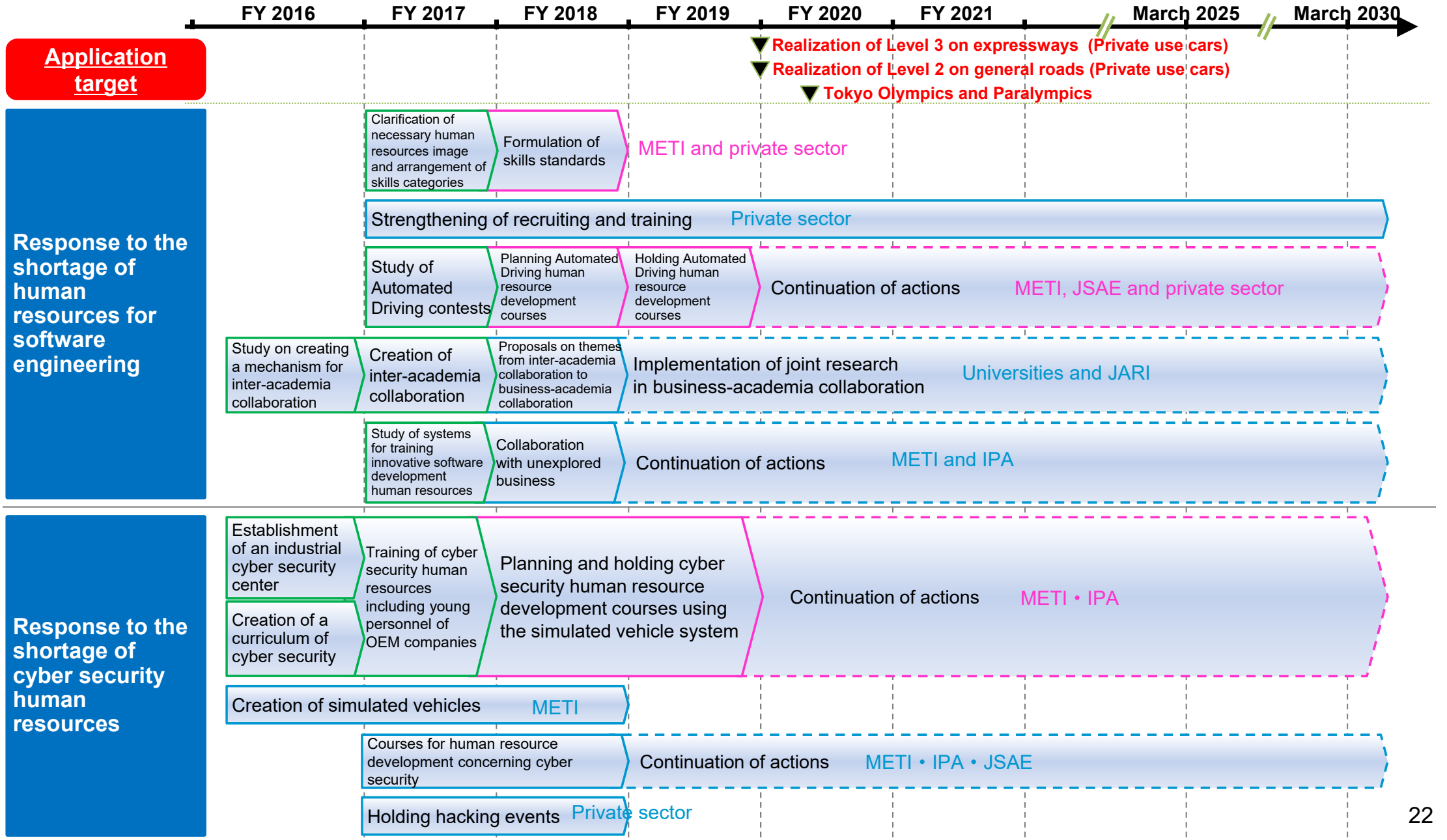


* Level alignment is required at each layer.

VIII. Human resources for software engineering

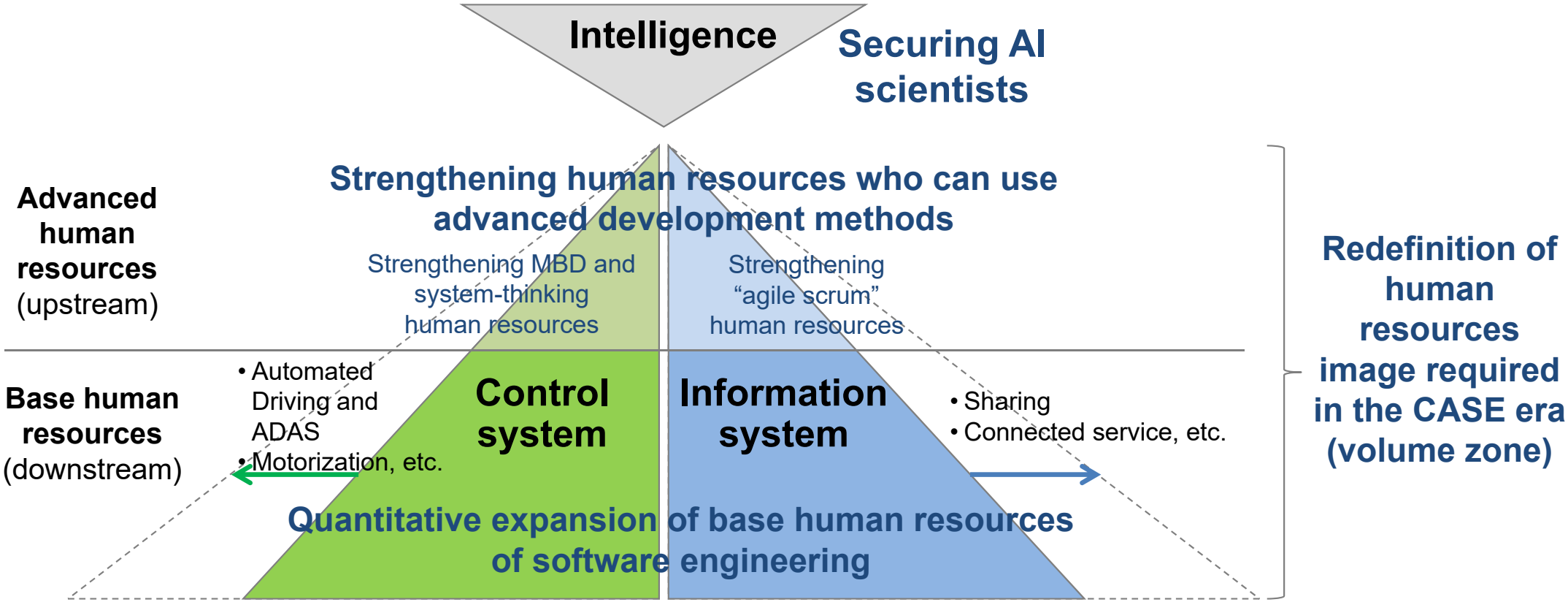
Completion
Underway and policies
Underway and policies (New)

Ideal future vision and policies
- Aim to discover, secure and train human resources for software engineering including cyber security, which is the core of development, to resolve the shortage thereof.
- Classified and arranged software skills and conducted a survey on discovery, securing and training of human resources for software engineering in F2017. In FY2018, promote the formulation of skills standards.
- Provided courses on cyber security in FY2017. Study efforts of cooperation among the automobile industry in advertising the need of cyber security human resources and attractive features of their jobs in the future.



<Reference> VIII. Human resources for software engineering

- Since the properties differ according to area and human resources for software engineering, it is necessary to consider responses separately.



Base (cyber security) system

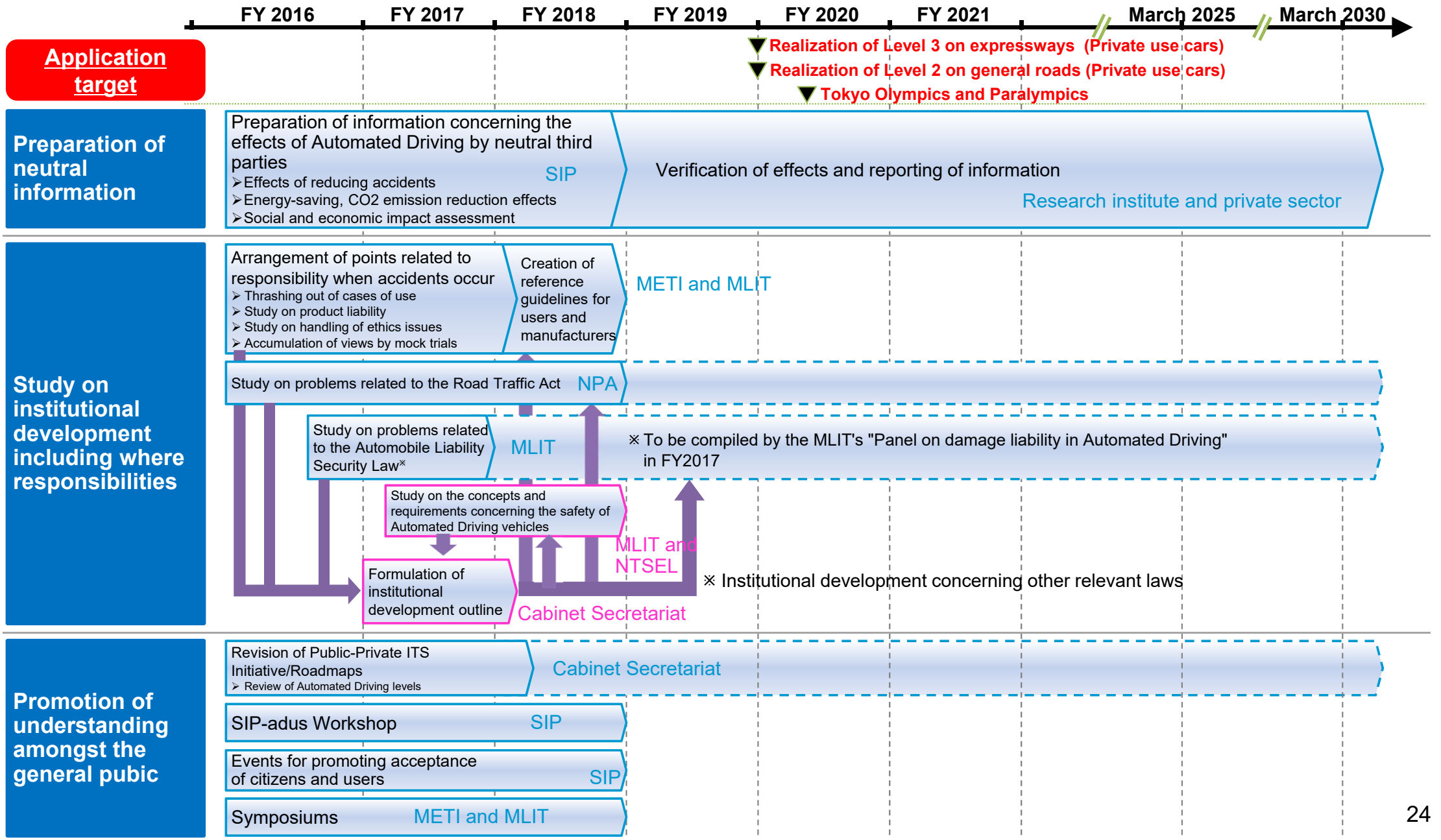
Securing base cyber security human resources

IX. Social acceptance

Completion
Underway and policies
Underway and policies (New)

Ideal future vision and policies

- Show effects and risks of Automated Driving and promote development of the system according to people's needs with the aim of developing the environment required for societal implementation.
- For its realization, present the effects of Automated Driving and define where responsibilities lie, which is a precondition of the spread of use of Automated Driving, and continuously report on the state of things.



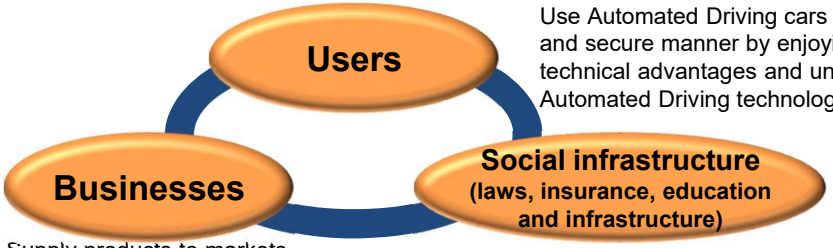
<Reference> IX. Social acceptance

- Discussions with users, businesses and experts on social infrastructure as to arranging points specific to Automated Driving relating to relief of victims, accountability and investigation into causes when accidents occur, as well as initiatives relating to promoting users' understanding of Automated Driving technology in order to introduce the Automated Driving system
- Enhancing people's understanding by publicizing the initiatives extensively through symposiums and events for promoting acceptance of the general public and users (dialogue with the general public) and promoting the initiatives by seeking people's opinions.

Where the responsibilities lie when accidents occur, promotion of people's understanding

- Study of problems newly arising from Automated Driving and solutions thereto
- While arranging accident scenarios and identifying risks of accidents and points of dispute by holding mock trials concerning civil liability, study matters that both manufacturers and users need to prepare and perform, and the concept of mutual communication.
- Take initiatives by closely watching overseas trends
- Enhance social acceptance of Automated Driving by reporting the current state of Automated Driving technology and through dissemination and awareness raising of safety support cars.
- While extensively disseminating what people should recognize and perform as to Automated Driving technology through symposiums, promote further initiatives by seeking people's opinions.
- Both manufacturers and users arrange what they should perform.

Values and roles of Automated Driving:
Direction of initiatives by each stakeholder and stakeholders in cooperation



Use Automated Driving cars in a safe and secure manner by enjoying technical advantages and understand Automated Driving technology

Supply products to markets with peace of mind, explain properly to users

Develop the institutional systems and environment required for security and safety

Front

Back

Mock trial

Symposiums

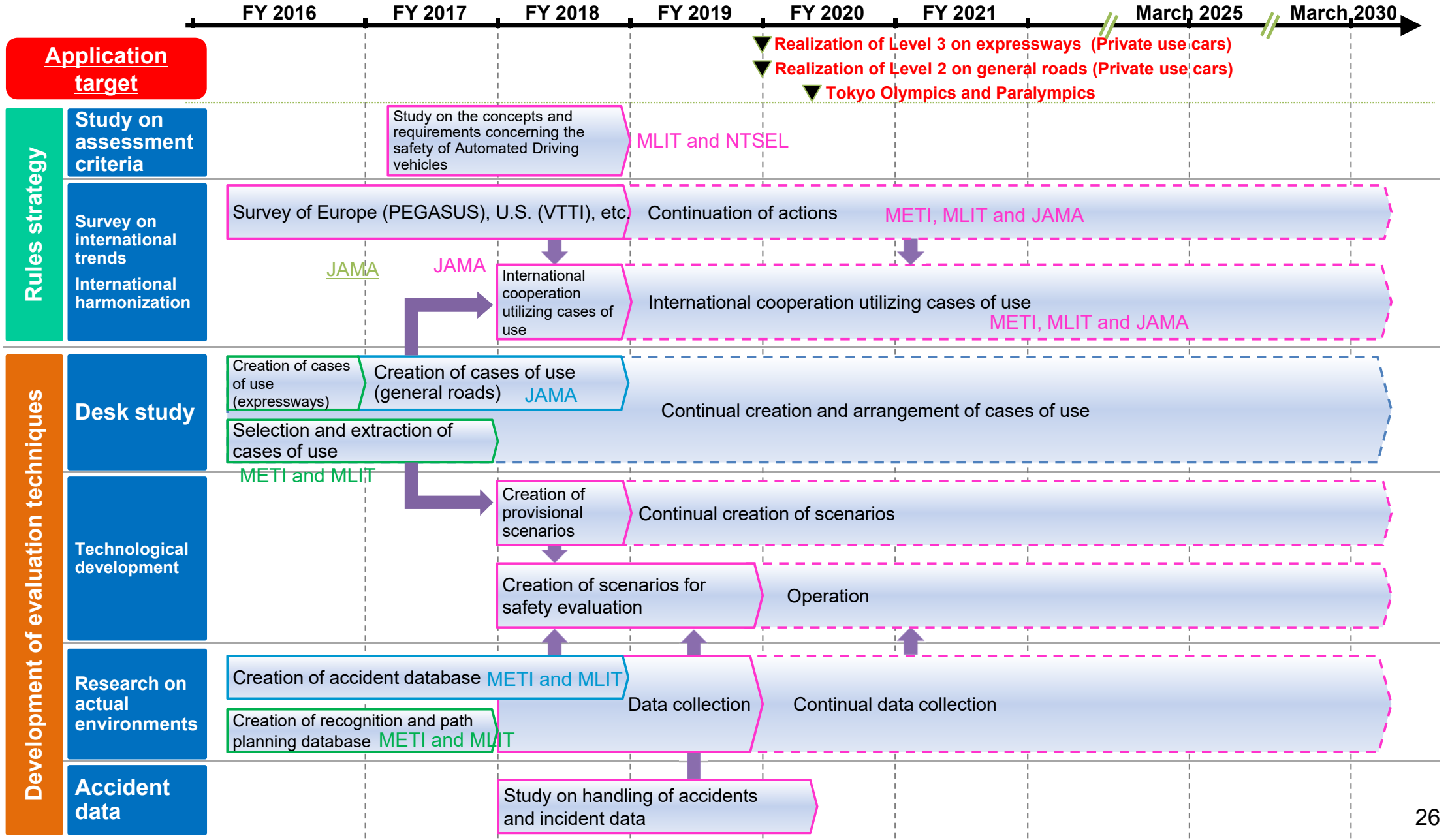
Event for promoting acceptance of citizens and users (dialogue with citizens)

X. Safety evaluation

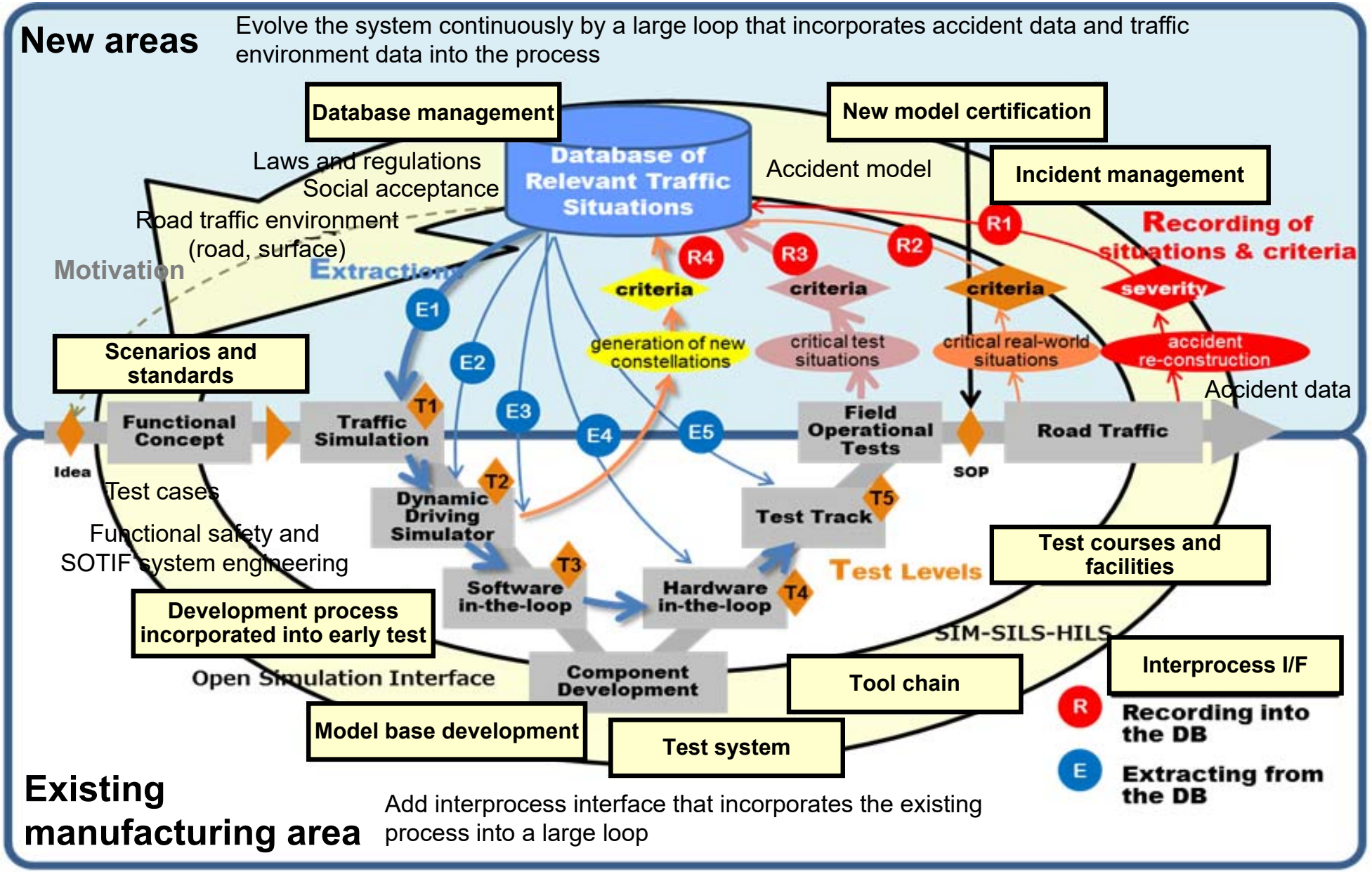
Completion
Underway and policies
Underway and policies (New)

Ideal future vision and policies

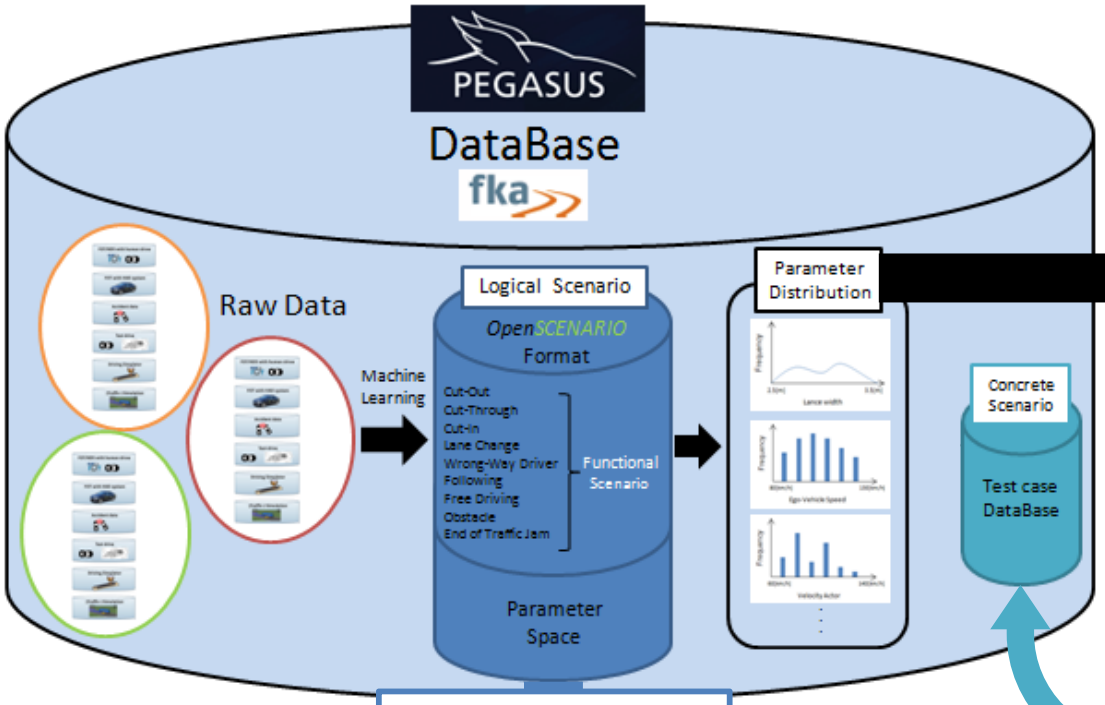
- Aim to create safety evaluation technology that utilizes the technologies that have been developed through the Panel on Business Strategies for Automated Driving, etc.
- Create scenarios that show traffic environments in Japan in cooperation and use the scenarios for international discussions. Also, study the handling of data concerning accidents that will occur in the future and use the data for safety evaluations.



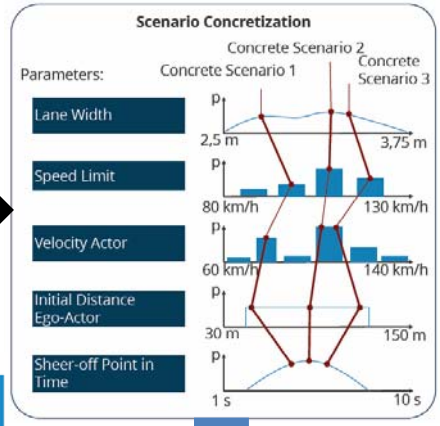
Automated Driving evaluation process in PEGASUS (Germany)



Evaluation test case generation process in PEGASUS (Germany)



Extract the dispersion of parameters in each scenario



Test Automation: Test Control (QTronic, ECU-TEST) / Test Derivation Stochastics Module (IFR, QTronic, ECU-TEST)

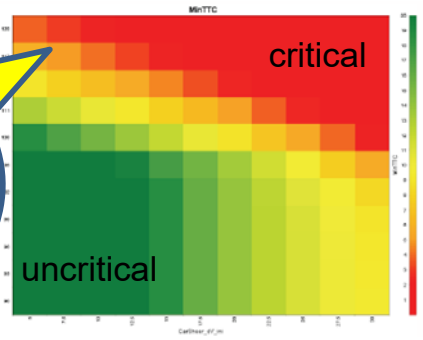
Create Concrete Scenarios in a combination of parameters (use Stochastics Model)

Concrete Scenario	Lane width [m]	Speed Limit [km/h]	Velocity Actor [km/h]	Distance [m]
Cut-In [ID1]	2.7	90	70	40
Cut-In [ID2]	3.0	100	90	80
Cut-In [ID3]	3.2	130	100	120

Accumulate Concrete Scenarios in Database

Create heat maps for each Logical Scenario in Simulation (Threshold value of Critical is based on Human Driver)

Test Automation: Test Control (QTronic, ECU-TEST) / Test Derivation Stochastics Module (IFR, QTronic, ECU-TEST)



Driving behavior of Human Driver is Criticality assessment criteria.

Evaluation test case

Select Critical Concrete Scenario

uncritical

Concrete Scenario	Lane width [m]	Speed Limit [km/h]	Velocity Actor [km/h]	Distance [m]
Cut-In [ID1]	2.7	90	70	40
Cut-In [ID2]	3.0	100	90	80
Cut-In [ID3]	3.2	130	100	120

critical

Extract by comparison between heat maps and Concrete Scenario

4. Demonstration Projects

(1) Truck platooning

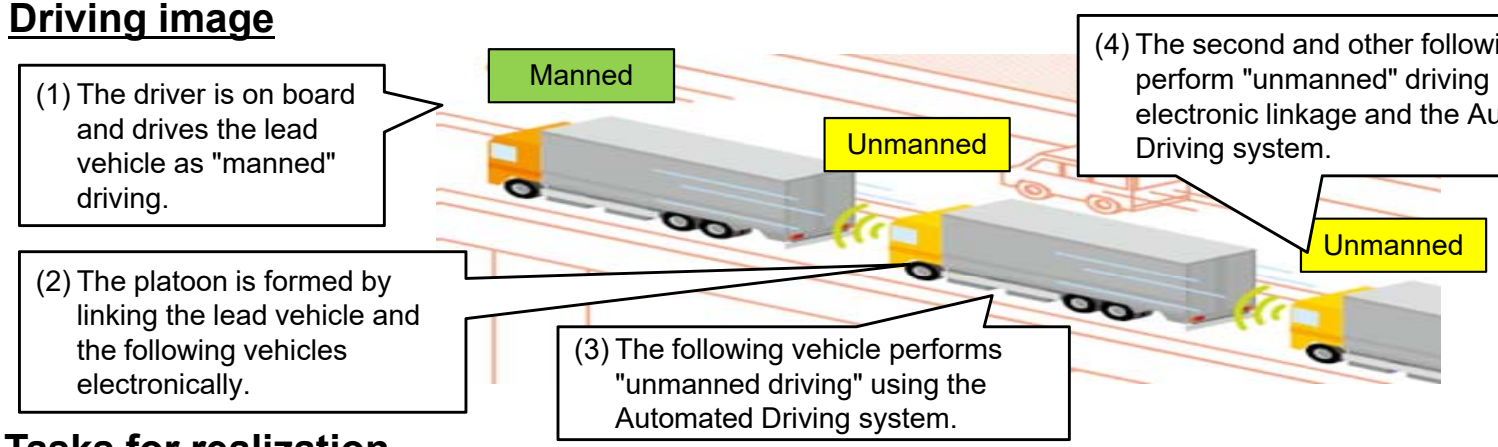
Ideal future vision

- Unmanned following truck platooning with expectations for resolving the shortage of drivers, reducing labor, and improving fuel consumption

Progress and policies for implementation

- Started the "Research, development and demonstration project for societal implementation of advanced Automated Driving systems: Demonstration for societal implementation of truck platooning (METI, MLIT) in August 2016.
- In FY2017, started a demonstration test of vehicle platooning on the Shin-Tomei Expressway using CACC made by different manufacturers, for the first time in the world using "manned" following vehicle platooning system in order to verify social acceptance, and conducted technical demonstration tests to check the response of the vehicle platooning to the difference in elevation on the road on the Kita Kanto Expressway.
- In FY2018, demonstration tests will be conducted on vehicle platooning using CACC with different loading conditions, with the LKA function added as well as using unmanned following vehicle platooning system on public roads (Shin-Tomei Expressway).
- Obtain the cooperation of the concerned parties including the relevant ministries and agencies, study the driving places and the center (facilities) for forming vehicle platoons as soon as possible, and realize truck platooning on expressways in 2020 by the steady steps including "manned" following vehicle platooning.

Driving image



Vehicle image

(provided by Hino Motors, Ltd.)

Heavy-duty 25 ton cargo truck

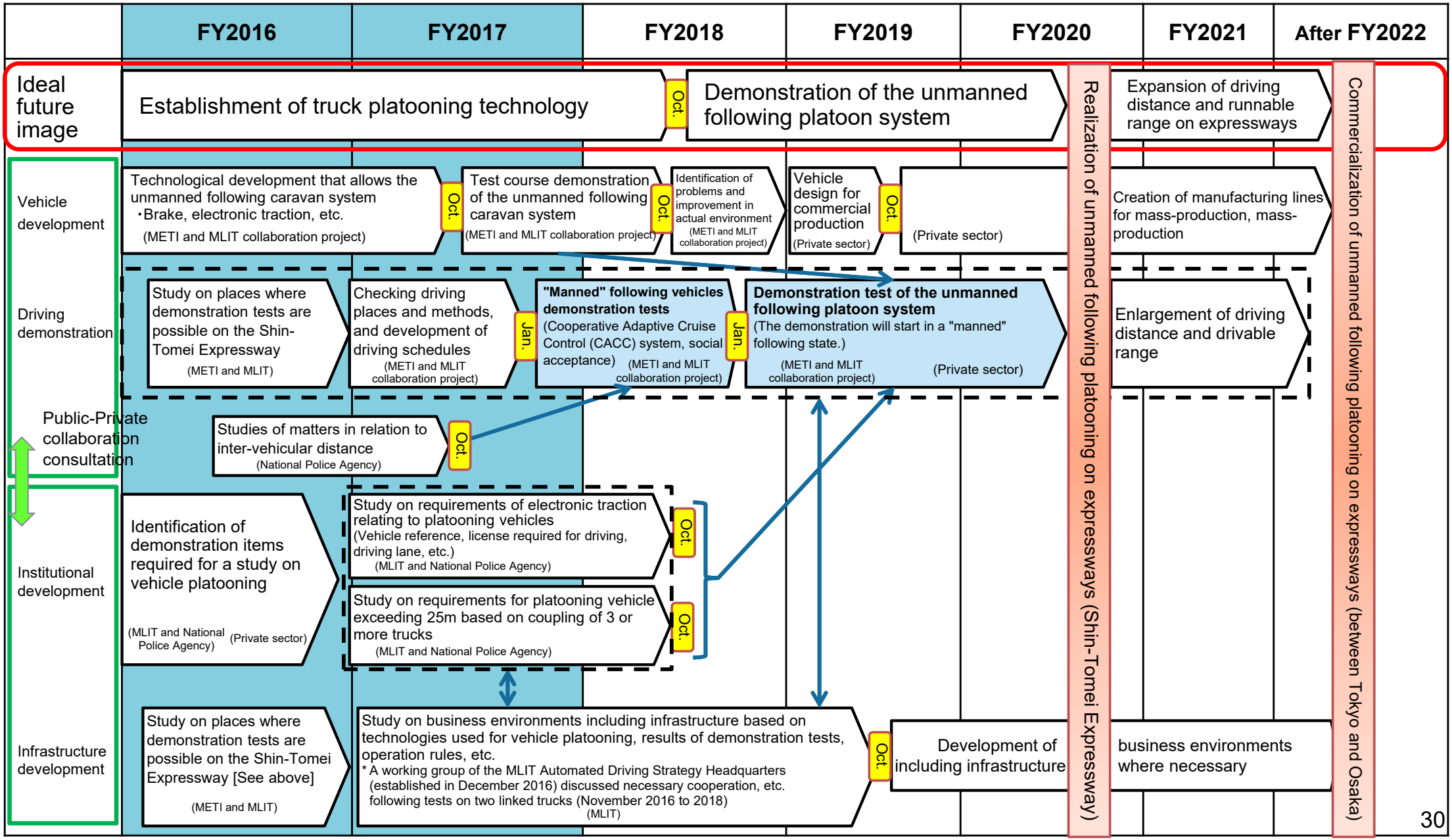
Tasks for realization

- ○ Clarification of the business model: Study of places where a long vehicle group can run in platooning and the operation of platooning that can be established as business.
- ○ Technological development and demonstration (resolving technical problems): Development of electronic traction system and advanced brake system required for realizing unmanned following vehicle platooning
- ○ Study of institutional systems and business environments: Study of the institutional handling concerning the technology required for realizing vehicle platooning in cooperation with the relevant ministries and agencies

4. Demonstration Projects

(1) Truck platooning

Road map for realization



4. Demonstration Projects

(1) Truck platooning <Reference material>

Electronic traction (electronic linkage) in vehicle platooning

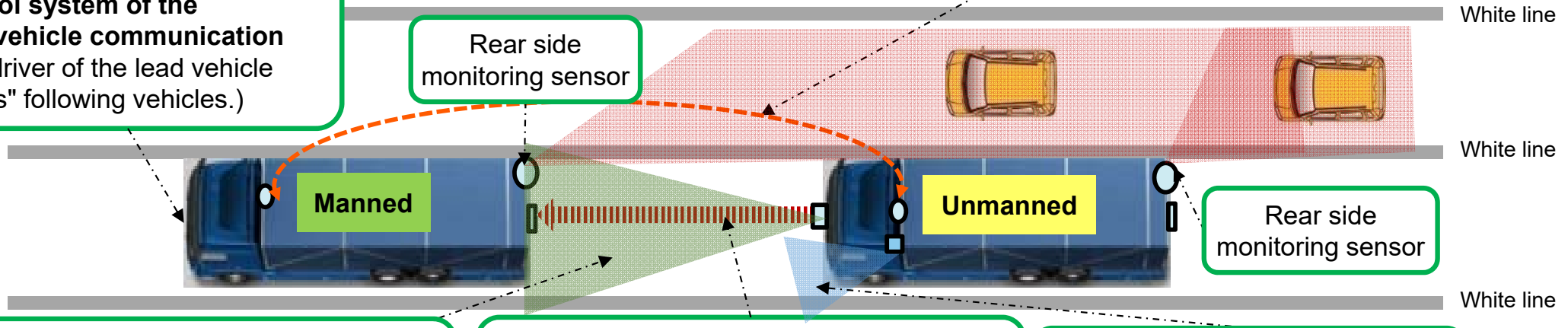
<Difference between physical traction and electronic traction>
In electronic traction, following vehicles are pulled by electronic linkage using inter-vehicle communication and sensors.

<Difference between CACC and electronic traction>
In electronic traction, the vehicles can run the traffic flow merging and leaving points without white lines and in service areas, and change lanes by crossing over white lines.

Image of electronic traction

Inter-Vehicle communication
(Automatically keep the inter-vehicular distance constant and transmit image and information of rear side to the driver so that the driver can monitor the surroundings)

Control system of the inter-vehicle communication
(The driver of the lead vehicle "pulls" following vehicles.)



Lead vehicle tracking sensor
(Used for following the lead vehicle even at the traffic flow merging and leaving points without white lines and lane changing)

Inter-vehicular distance sensor <millimeter-wave radar>
(Used for keeping the distance between the lead vehicle and non-traction vehicle constant)

White lines recognition camera
(Used for correcting the driving position on a road with white lines)

Future technical tasks

- Establish technology for maintaining communication so that safety can be ensured even in all sorts of bad weather.
- Establish technology for maintaining safe vehicle behavior by ensuring communication speed.
- Establish technology for taking measures such as stopping the vehicle safely when an failure occurs.

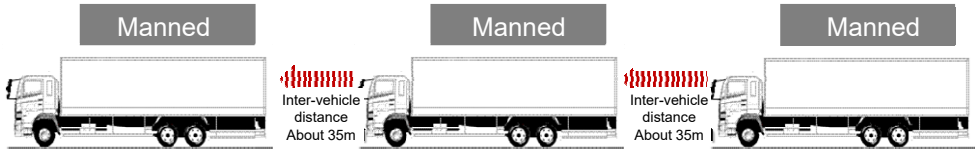
4. Demonstration Projects

(1) Truck platooning <Reference material>

"Manned" following vehicle platooning system demonstration test (Shin-Tomei Expressway)

■ **Purposes and verification matters**

- Disseminate extensively the development of vehicle platooning for future introduction.
- Grasp the recognition degree of vehicle platooning by surrounding vehicles (Attach platooning indication LED lights to cargo beds of test vehicles.)
- Check the view from surrounding vehicles when the vehicle platoon flows in and out of the traffic flow and runs inside lanes.



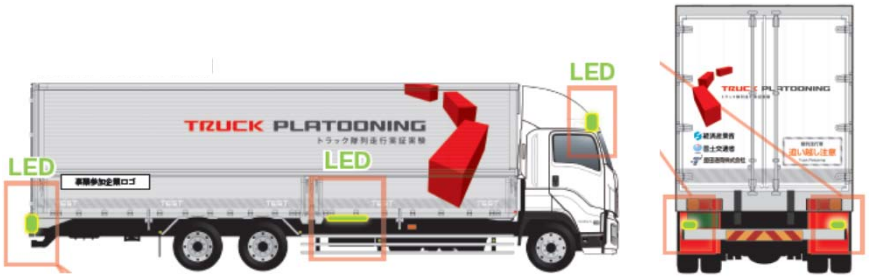
■ **Period:** January 23 to 25, 2018 (*when the vehicle speed is 80 km/h)

■ **Section:** Between Shin-Tomei Expressway Enshu Mori-Machi PA and Hamamatsu SA

■ **Loading conditions:** All vehicles are empty (no load)

■ **Vehicles used:**

- Accelerator and brake operations are automatically controlled by the CACC function.
- Platooning is indicated on the cargo bed of test vehicles.
- LED lights are installed on the front, rear and sides of the vehicle.

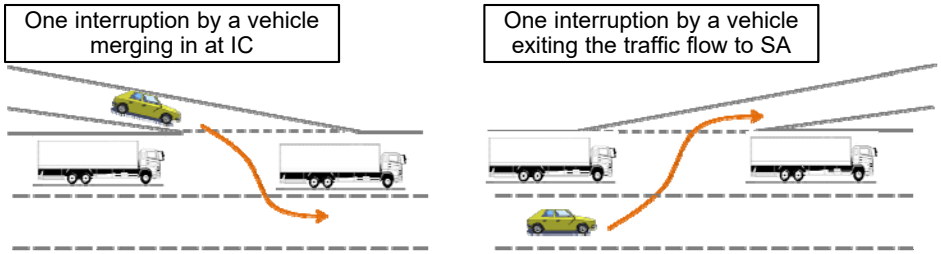


CACC system (Cooperative Adaptive Cruise Control system)
Function for receiving control information of the lead vehicle via communication and automatically accelerating and decelerating to keep the inter-vehicular distance constant

■ **Results**

(1) Driving state of trucks (mixture of two and three lanes at the ratio of 2:3)

- Two interruptions occurred during demonstration tests (15 km x 13 times) (inter-vehicular distance 35 m)



- Traffic congestion occurred due to trucks that passed the vehicle platoon in a section of two lanes.

(2) Interviews of the trial subjects

1) Observation vehicle monitor

- There was no anxiety or difficulty because the truck ran more stably than in conventional driving.
- It is necessary to indicate platooning and disseminate the driving method.
- There were concerns at the time of interruptions and merging with and leaving traffic flow.

2) Truck drivers

- There is concern that cars are backing up behind the platoon when low-speed vehicles pass the vehicle platoon.
- It is difficult to change lanes in heavy traffic.
- It is difficult to change lanes when the number of lanes is reduced.

(3) Questionnaire survey of general drivers

- I felt no difference between trucks platooning and normal trucks.
- It is better to indicate the platooning trucks.

(It is considered that driving in vehicles platooning is easier in a section of 3 lanes than a section of 2 lanes.)

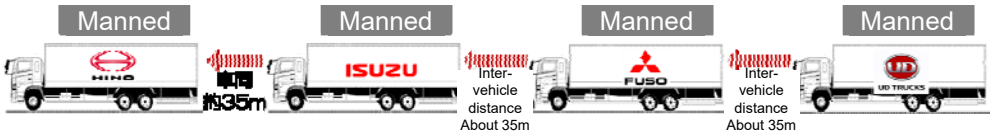
4. Demonstration Projects

(1) Truck platooning <Reference material>

"Manned" following vehicle platooning system demonstration test (Kita Kanto Expressway)

■ **Purposes and verification matters**

- CACC operation verification between vehicles made by different manufacturers
- Technical checking if a change in inter-vehicle distance (such as increase in distance) occurs on gradients (sag part) or curves



(*when the vehicle speed is 80 km/h)

■ **Period:** January 30 to February 1, 2018
■ **Section:** Kita Kanto Expressway Mibu PA to Kasama PA
■ **Loading conditions:** All vehicles are empty (no load)

■ **Results**

(1) Operation state of CACC

- CACC operated normally in the platooning of 4 trucks made by different manufacturers in all running sections.
- When the vehicle in front decreased speed, the following vehicles stably followed.

2nd vehicle started deceleration

3rd vehicle started deceleration

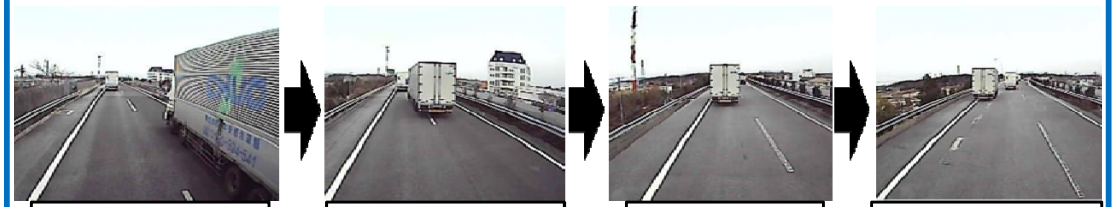
4th vehicle started deceleration

(2) Inter-vehicle distance change due to gradient

- CACC has no large superiority. (It is considered running conditions were extremely stable.)

(3) Driving state of trucks (2 lanes in all sections)

- A total of 20 interruptions occurred during running (about 50 km x 12 times)
- Compared with the demonstration on the Shin-Tomei Expressway, the number of interruptions greatly increased. (It is considered that results were affected by factors such as two lanes in all sections, short acceleration lane in sections where merging with traffic, long platooning of 4 trucks, and many traffic flow merging and leaving points.)



A large vehicle is passing

A large vehicle is interrupting

Follows the platooning

A large vehicle leaves from traffic flow

- Other matters that become obstacles of driving

1) Passing by a low-speed vehicle

A low-speed vehicle blocks the lane together with platooning vehicles.

2) Occurrence of disabled vehicle

Lane changing is required.

4. Demonstration Projects

(2) Last mile Automated Driving system

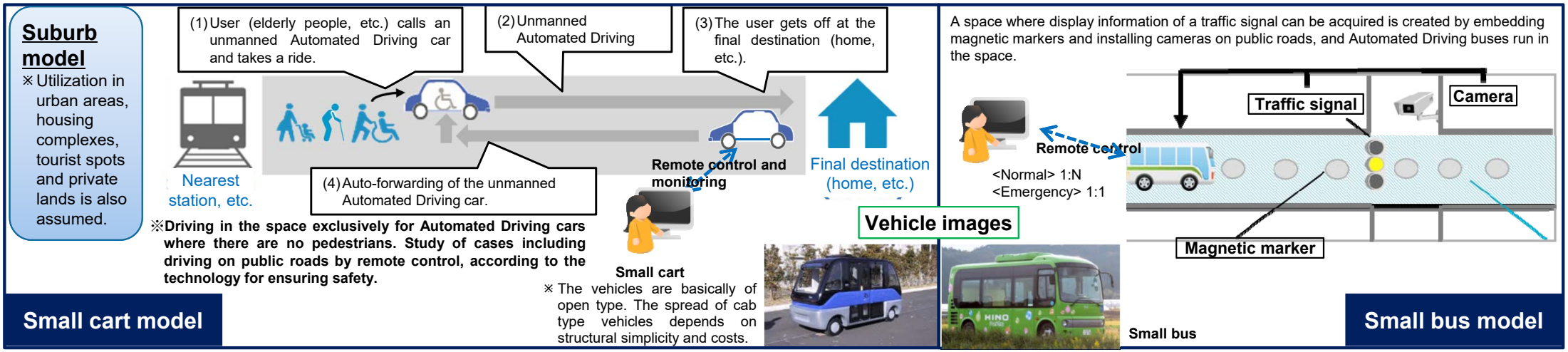
Ideal future vision

- New mobile service for restraining operation costs and resolving the shortage of drivers in depopulated areas

Progress and policies for implementation

- Started the "Research, development and demonstration project for societal implementation of advanced Automated Driving systems: Demonstration for societal implementation of terminal traffic systems using Automated Driving, etc. in exclusive space" (METI, MLIT) in September 2016.
- In FY2017, started demonstration tests in Wajima City, Ishikawa (Automated Driving with no person in the vehicle was performed as the first case on public roads in Japan) and Chatan Town, Okinawa to perform technological verification of the system and evaluate the acceptance of business.
- In FY2018, [1] the demonstration test period in some areas will be extended for up to one month. [2] Local businesses, etc. perform remote control. [3] One remote monitoring operator operates several vehicles.
- Establish a system that can minimize operation costs, materialize the business model, and realize unmanned mobile service in 2020.

Service image



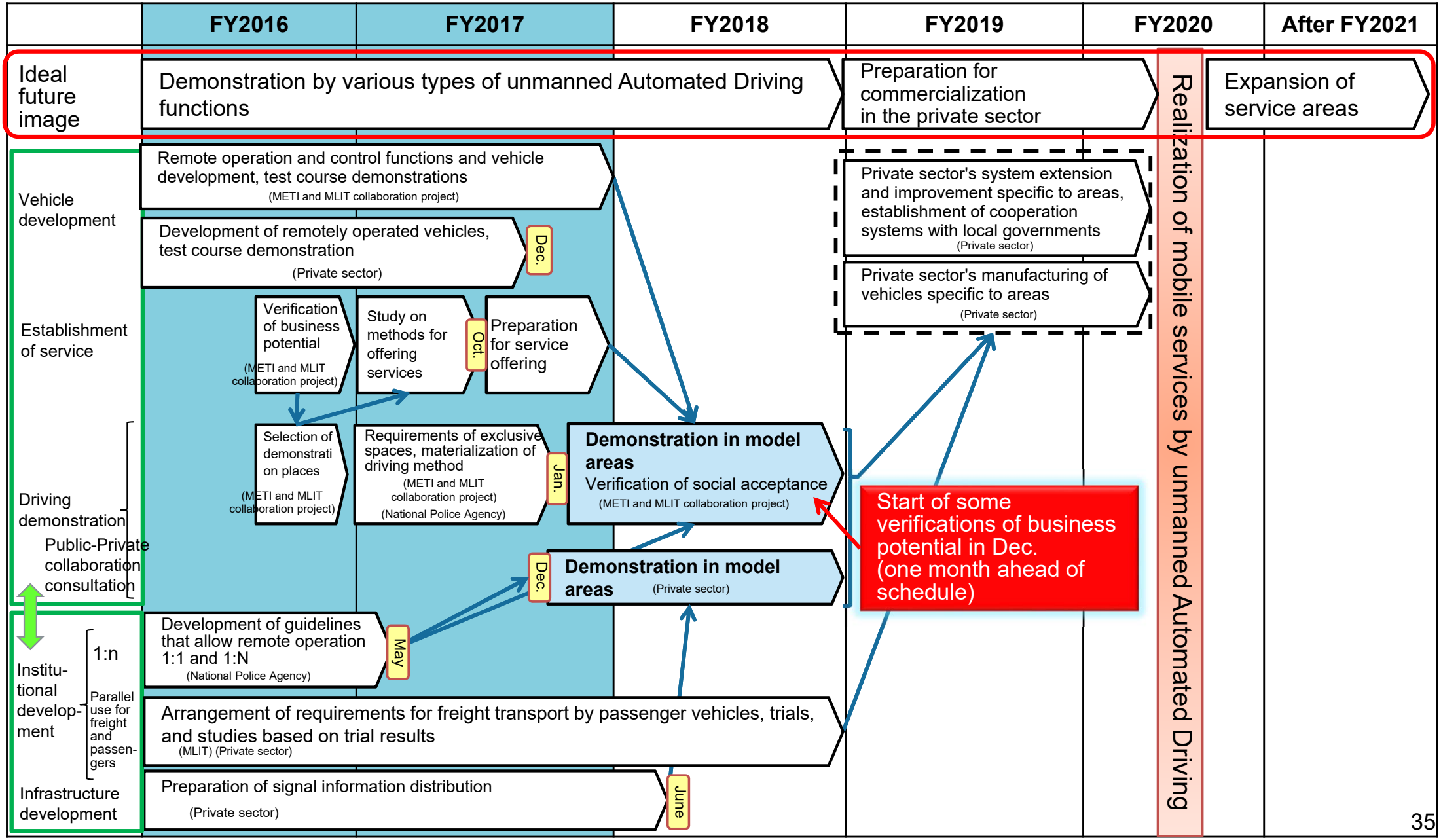
Tasks for realization

- ○ Clarification of business potential and evaluation of social acceptance: Study of operating patterns that can be established as business and a mechanism of coexistence between vehicles with no driver inside and other vehicles, pedestrians, etc.
- ○ Technology development and demonstration (resolving technical issues): Development of technology for safe running without drivers in vehicles, and improvement of control technologies such as remote monitoring and operation
- ○ Study of institutional systems and business environments: Study on institutional handling concerning Automated Driving without drivers in vehicles and driving of many small capacity vehicles in cooperation with relevant ministries and agencies

4. Demonstration Projects

(2) Last mile Automated Driving system

Road map for realization



4. Demonstration Projects

Small cart selection areas: Okinawa Chatan Town (Chatan Town Office)

Means for moving from hotels to tourist spots using a course on municipal land along the coast

1. Outline of the area

Outline:
Tourist spot with two beaches and an American village
Population: About 29,000
Number of tourists: About 660,000
(Foreigners: About 260,000)

2. Driving route

Fixed points for getting on/off the cart

Phase 1: approx. 1km
(1) In front of Uminchu wharf (start/end points)
(2) In front of Chatan Harbor Brewery
(3) In front of Hilton hotel
(4) In front of Depot Island
(5) Sunset beach north

Phase 2: approx. 1.7 km
(1) Sunset beach
(2) In front of Chatan pool
(3) In front of Chatan Stadium Court
(4) In front of Chatan Shiokawahashi
(5) Araha beach (Turning point)

- **Tourist spot model:** Activation of tourist spots
  - Circuiting service between tourist facilities, hotels, etc.
  - Promoting demands of tourists (use of road facilities)
  - Ensuring safe transportation for mobility vulnerable people
- Users
  - Tourists using tourist facilities and hotels
- Driving route
  - The course for circuiting tourist facilities, hotels and beaches is on municipal land along the coast (non-public road) (about 3km).
- Demonstration tasks
  - **Automated Driving in a space of coexistence with humans, etc.**
  - **Response to congestion with people (continuation of safety and operation)**
  - **Remote unmanned operation and forwarding (on promenade)**
  - Added-values such as response to foreign visitors and security, and business potential
  - Response to changes in demand (increasing the number of carts and linking carts)

Phase1:
Sunset Beach ... Hotel ... Uminchu Wharf
Phase2:
Uminchu Wharf ... Sunset Beach ... Araha Beach
➢ Demonstration test can be conducted on the Phase 1 route in advance.
On the Phase 2 route, an electric cart (6 passengers) of Hilton Hotels is running at present. (Number of users in FY2015: 5,200)

4. Demonstration Projects

Small cart selection areas: Wajima City, Ishikawa (Wajima Chamber of Commerce and Industry)

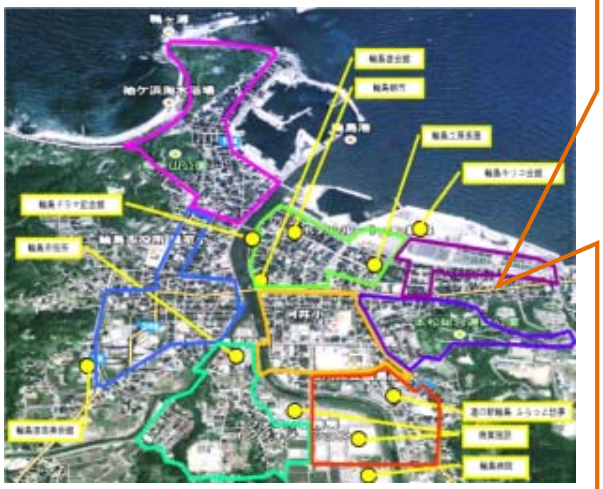
Means for moving residents and circuiting tourist spots using several routes

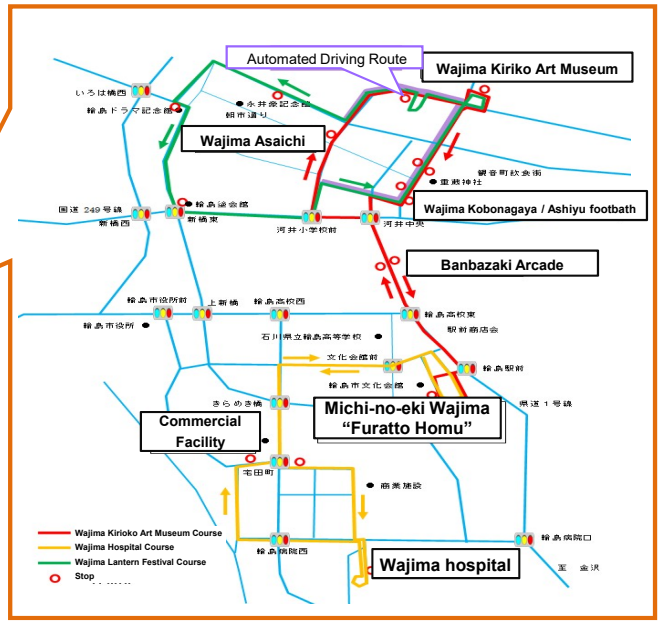
1. Outline of the area

Outline:
One-third of the city population is concentrated in the area where life and tourist facilities are found.
Population:
In the area: 9,143 people
Entire city: 28,426 people
Aging population ratio: 43.1%
Number of tourists: 1,320,500 (2016)
(Number of lodgers: 188,700) (2016)

- **Urban area model:** Activation of a city with aging population
  - Circuiting mobility service between life and tourist facilities
  - Ensuring safe transportation for mobility vulnerable people
  - Promoting demands of tourists (use of road facilities)
- Users
  - Residents using life facilities, tourists using tourist facilities
- Driving route
  - Course that circuits between life facilities and tourist spots in the city (Several courses: about 1 to 4 km)
- Demonstration tasks
  - **Automated Driving in a space of coexistence with other vehicles on public roads**
  - **Response to signals, intersections and parking vehicles**
  - **Remote unmanned operation and forwarding (on general public roads)**
  - Added-values such as public relations and security, and business potential
  - Response to changes in demand (increasing the number of carts and linking carts)

2. Driving route





- ✓ Set the course for circuiting between tourist spots and life facilities.
- ✓ 8 courses (central figure) are assumed in the future and demonstration is assumed on 3 courses (right figure).
- ✓ Automated Driving using electromagnetic induction lines partially started in November 2016.
- ✓ Manually operated electric carts are operating at present.

4. Demonstration Projects

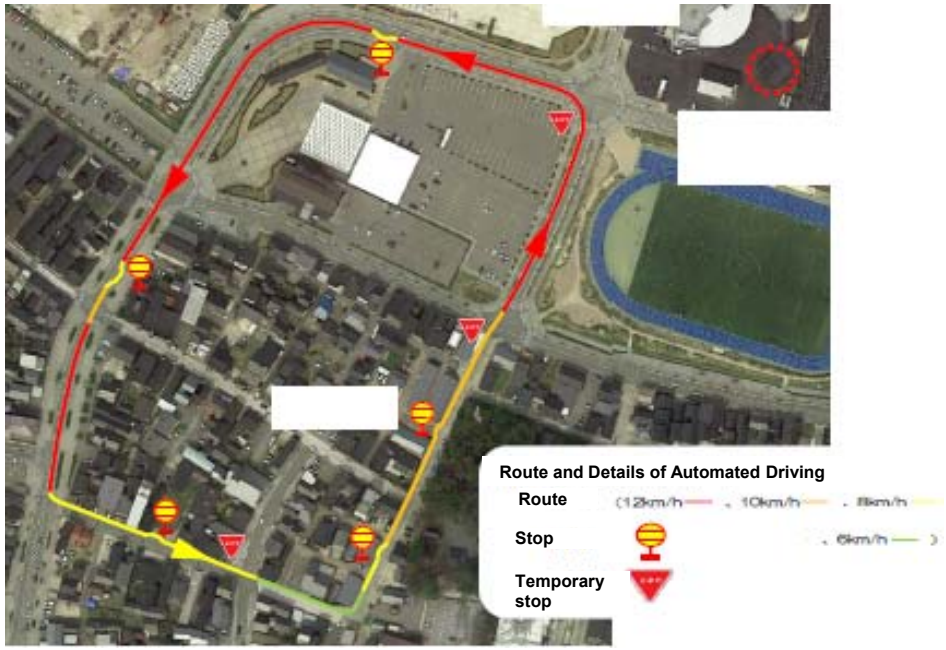
Small cart selection areas: Wajima City, Ishikawa (Wajima Chamber of Commerce and Industry)

(2) Demonstration outline

■ **Purposes and verification matters**
- Technological demonstration including unmanned vehicle system

■ **Period**: December 17 and 18, 2018
- The kickoff ceremony was held on December 18, 2017. The demonstration test for societal implementation of a terminal traffic system with Automated Driving by remote control that combines remote monitoring and operation technology and Automated Driving was the first such demonstration of remote controlled Automated Driving using unmanned vehicles on general public roads in Japan.

■ **Driving route and base of the test (About 1 km circuit with electromagnetic induction lines installed)**



■ **Results**

(1) When driving operation in the remote driver's seat becomes necessary
- There was no example of unexpected driving operation by the remote driver.
- Maintenance staff was asked for help in dealing with the parked vehicles because there was snow on the ground (1 km x 15).
- The remote driver started the cart from temporary stops at cart stops and intersections.

(2) When trouble occurred
- Some erroneous detection of sensors due to rain and snow
- Effect on steering control of side slipping of tires on snowy road surface.
- Effect of the low temperature environment on the power supply unit (communication, etc.): ⇒ Robust measures

(3) Additional measures after criteria relaxation, future improvement
- Improvement of the safety of Automated Driving without persons in vehicles such as by stopping the vehicle using a wireless unit in the surrounding area without maintenance staff on board
- Strengthen Automated Driving functions for reducing operation burden of the remote operator
- Study and demonstration of running intension indicating methods for allowing concessions (light, electronic display, etc.)
- Control with enhanced safety such as those of sensor detection distance, passing rate, and path planning

Demonstration of Automated Driving with no person in the vehicle

Remote monitoring and operation

4. Demonstration Projects

Small cart selection area: Eiheiji Town, Fukui (Eiheiji Town and Fukui Prefecture)

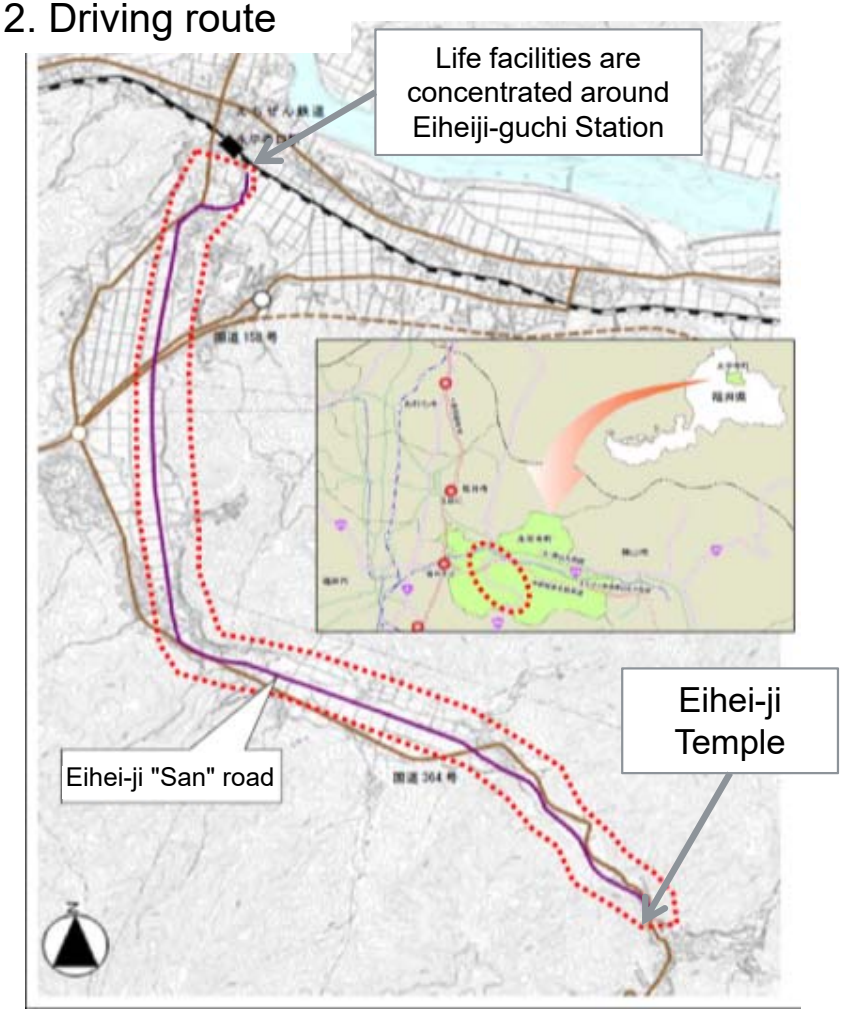
Round-trip from the station to residential areas and tourist facilities. Parallel use by residents and tourists.

1. Outline of the area

Outline: Tourist spots centering on Eihei-ji Temple
Population: 2,697 (2015)
Number of tourists: 581,262 (2015)
(Foreign people: 10,754)
Aging population ratio: 27.5%

- **Depopulated area model:** Activation of the area with falling birthrate and aging population
  - Round-trip from the station to residential areas and tourist facilities. Parallel use by residents and tourists.
  - Ensuring safe transportation at night and in the snow
  - Promotion of the demand of tourists (use of promenade and road facilities)
- Users
  - Parallel use of commuters for school or work, residents using life facilities and tourists
- Driving route
  - Eihei-ji "San" road (promenade made using old Eiheiji line site): About 6 km between Eiheiji-guchi Station and Eihei-ji Temple (two lines of 4 km and 2 km are scheduled to be linked)
- Demonstration tasks
  - **Automated Driving in a space of coexistence with people on the promenade**
  - **Response to crossing intersections with public roads (traffic signals, railway crossing, etc.)**
  - **Driving at night and in the snow**
  - Added-values such as nighttime security and tour information, and business potential
  - Remote unmanned operation, response to the changes in demand (increasing the number of carts and linking carts)

2. Driving route



- ✓ Connect between Eiheiji-guchi and Eihei-ji Temple.
- ✓ Means for moving commuters for school or work to Eiheiji-guchi Station in the morning and at night
- ✓ Means for moving tourists to Eihei-ji Temple during the daytime.
- ✓ Use the promenade ("San" road) of abolished line site.

4. Demonstration Projects

Small cart selection area: Hitachi City, Ibaraki (Hitachi City Office)

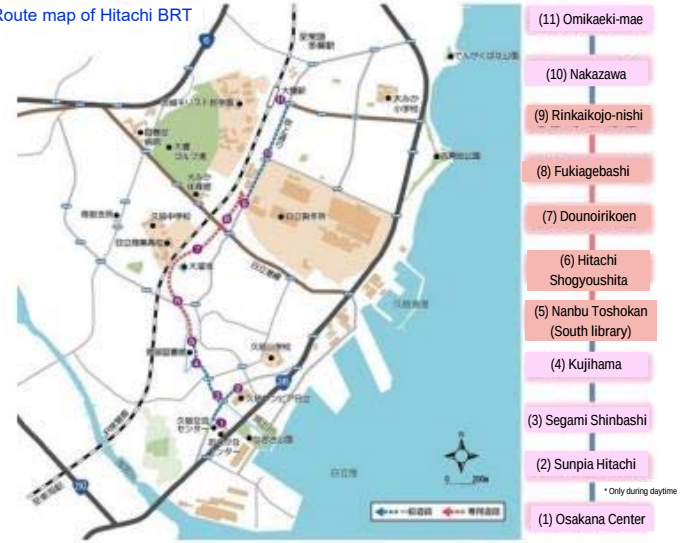
Demonstration of the Automated Driving system in Hitachi BRT (bus exclusive road using abolished line site)

1. Outline of the area

Outline:
Industrial town in northern Ibaraki Prefecture. Securing a means for moving elderly people, etc. and chronic traffic congestion are problems.
Population: About 182,000
Aging population ratio: About 30%

2. Driving route

Route map of Hitachi BRT



[1st term route of Hitachi BRT]

- **Community bus:** Activation of the city area
  - Securing a means for moving elderly persons, etc. and people commuting to school or work
  - Dissolution of chronic traffic congestion in surrounding roads
  - Resolving labor shortage and cost reduction of bus business
- Users
  - People commuting to school or work, residents using life facilities
- Driving route
  - Bus exclusive road of Hitachi BRT using abolished line site (about 1.3 km)
- Demonstration tasks
  - **Creation of exclusive space through infrastructure cooperation and Automated Driving on public roads**
  - **Creation of exclusive space (abolished line site, public road crossing parts)**
  - **Safe and secure remote operation management (monitoring)**
  - Business potential of BRT by eliminating drivers (cost effect)
  - Expandability to general public roads

- ✓ Using the abolished line of a local railway (Hitachi Dentetsu Line), started the BRT (bus rapid transit) operation in some sections in March 2013 (exclusive road: about 1.3 km).
- ✓ An extension of the line is scheduled in FY2017 (exclusive road: about 4.8 km).
  - ➢ Not only exclusive roads but also sections of general roads can be used for demonstration and evaluation.
  - ➢ It is necessary to reduce operation costs to secure and maintain familiar means of mobility of elderly people, etc.
  - ➢ Number of BRT users in FY2015: 550 per day (weekday)

4. Demonstration Projects

(3) Fully automatic parking

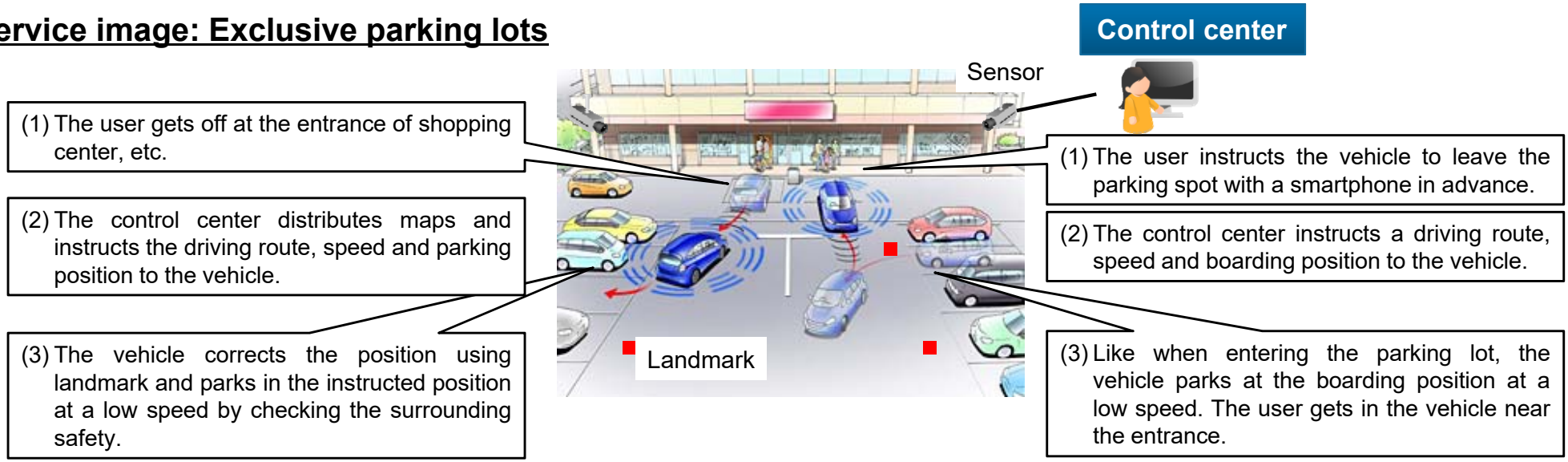
Ideal future vision

- There are expectations in fully automatic parking from the perspectives of improved safety, customer satisfaction, and management efficiency.

Progress and policies for implementation

- Started "Research, development and demonstration project for societal implementation of advanced Automated Driving systems: Demonstration for societal implementation of fully automatic parking for general vehicles" (METI, MLIT) in August 2016.
- In FY2017, started discussion of international standardization with other countries as to system requirements of vehicles, control centers and parking lot infrastructure.
- While utilizing simulation, form an agreement among parties concerned through demonstrations and promote the materialization of business model from FY2018. Realize fully automatic parking in exclusive parking lots after 2021.

Service image: Exclusive parking lots



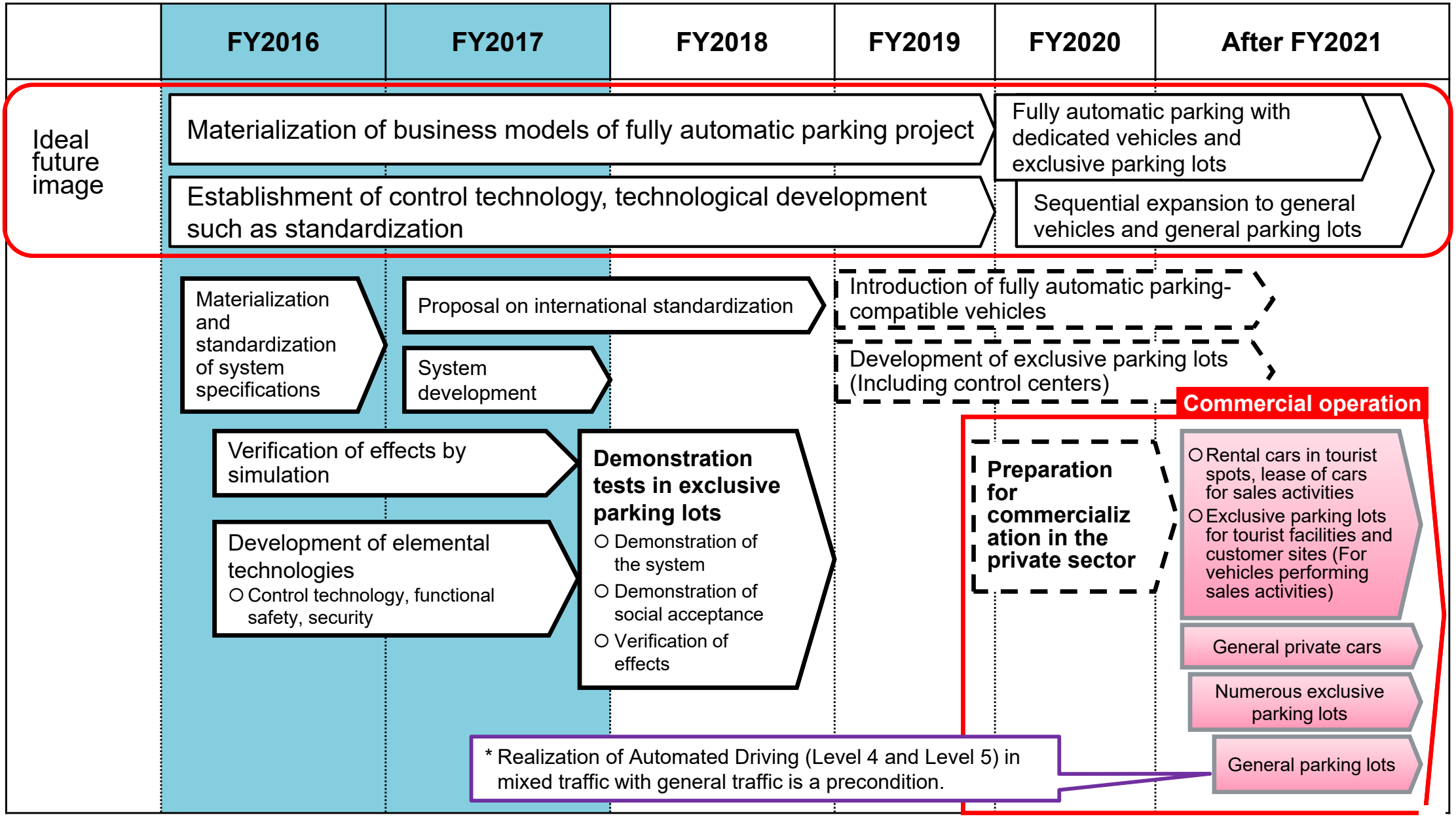
Tasks for realization

- ○ Clarification of business model: Study of operating patterns that can be established as business and a mechanism of coexistence between vehicles with no driver inside and other vehicles, pedestrians, etc.
- ○ Technology development and demonstration (resolving technical problems): Development of technology for safe running without drivers in vehicles, etc.
- ○ Study of the institutional systems and business environments: Study of the institutional handling concerning Automated Driving without drivers in vehicles in cooperation with the relevant ministries and agencies

4. Demonstration Projects

(3) Fully automatic parking

Road map for realization



5. Strategic Initiatives Concerning Rules (Criteria and Standards)

Criteria

- Japan co-chairs the "Automated Driving Subcommittee" and "Automatic Steering Expert Meeting" in United Nations WP 29 with the UK and Germany respectively, in which role it is tasked with leading international discussions.
- To study Japan's policy, further strengthen the system with the participation of the government, National Traffic Safety and Environmental Laboratory, automobile manufacturers, and suppliers.

Standards

- By taking the complicated relationship between ISO/TC22 (vehicle) and ISO/TC204 (ITS) into consideration, the "Automated Driving Standardization Study Panel" was established under the Society of Automotive Engineers of Japan to make cross-sectional communication smooth.
- It is necessary to continue studying the development of human resources for conducting standardization activities and strengthen the mechanisms and budget for securing resources.

Coordination between criteria and standards

- Based on the study system for criteria and standards, promote the initiatives using the "Automated Driving Criteria Institute" as a place for strategic study for linking criteria and standards.

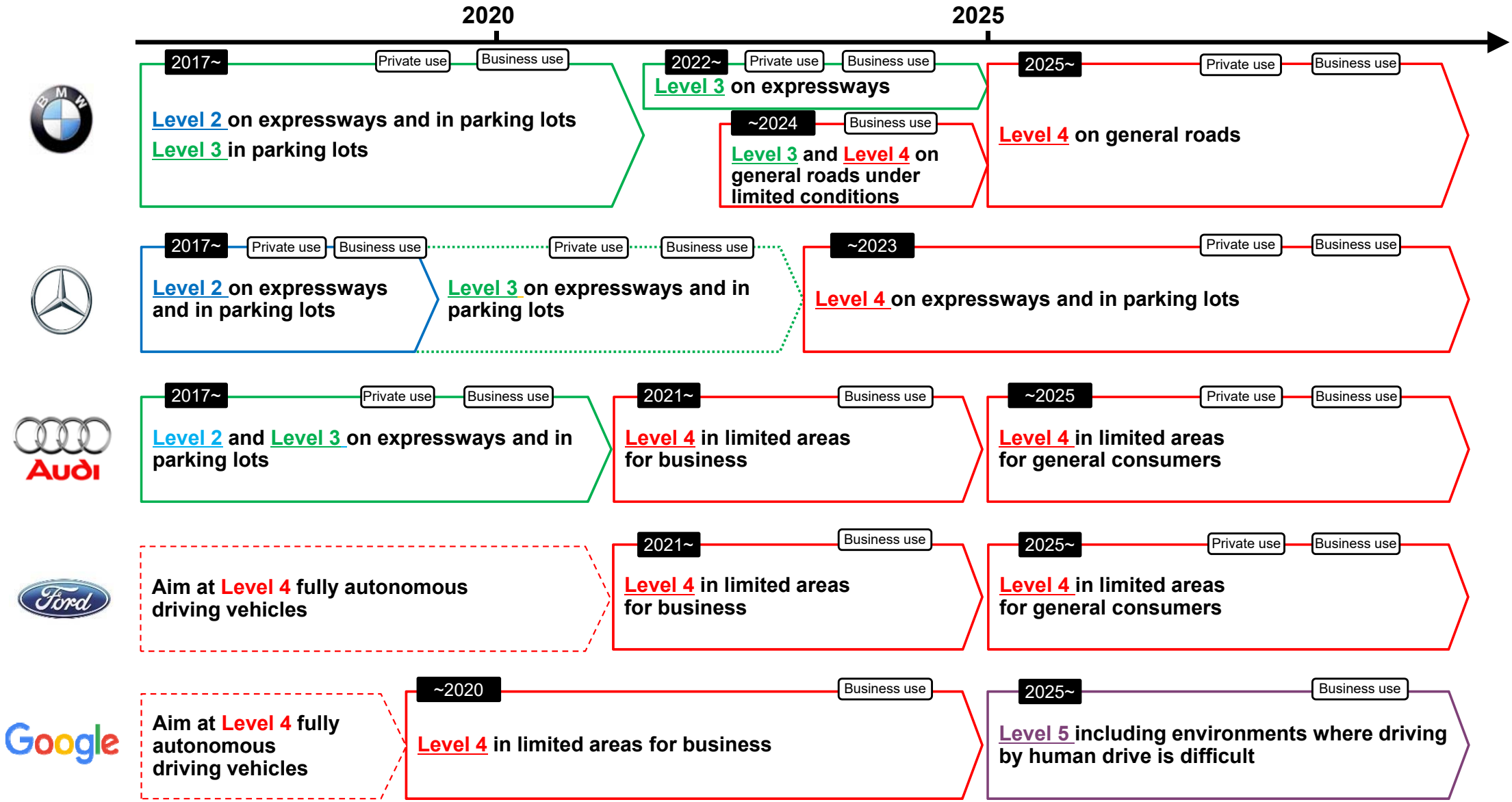
6. Promotion of Industry-Academia Collaboration

- It is necessary to establish a system for studying "cooperative areas" for universities and research institutes in Japan to meet expectations placed in their functions, human resources, facilities and environment. Also, to have universities and research institutes play their roles, it is necessary to create a mechanism that allows the exchange and supply of human resources among industry, universities and research institutes, research funding by government and industry, and improvement to facilities.
- Started discussions for establishing an academia collaboration system that can compete with overseas industry-academia-government research organizations, deal with problems specific to Japan and support " cooperative areas".
- To realize "full-fledged joint research" with all organizations involved, the "Guidelines for Strengthening Joint Research in Industry-Academia-Government Collaboration" was indicated. Industry-Academia collaboration was promoted in line with these guidelines.

<Reference> Overseas trends

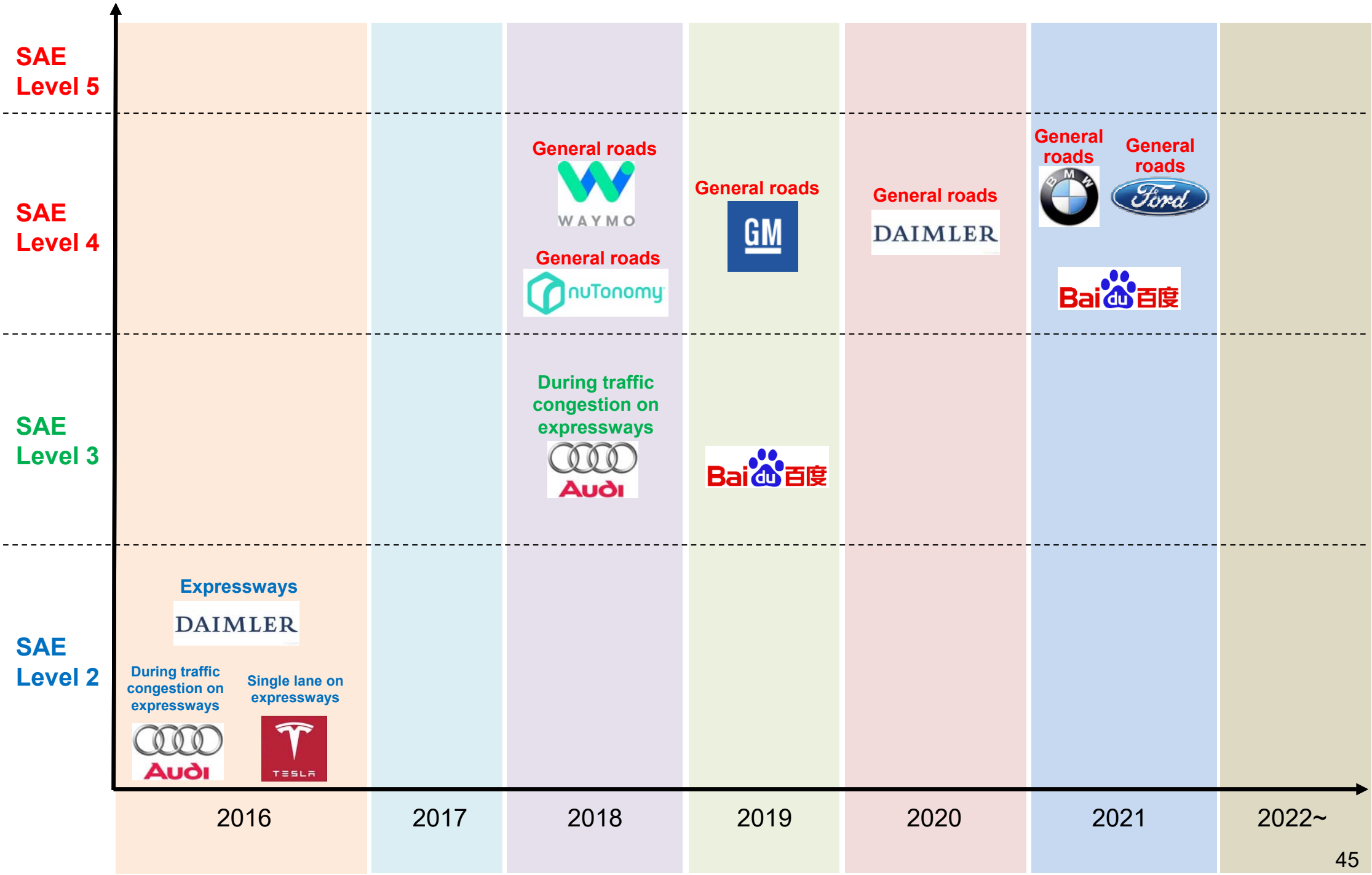
Ideal future vision

- European and American automobile manufacturers aim to realize Automated Driving not only centering on private cars but also targeting cars for business use in cooperation with service businesses.
- European manufacturers aim to realize Automated Driving using infrastructure, while American manufacturers aim to realize Automated Driving as soon as possible in specific areas by prioritizing automotive technologies.



*The roadmap of Google show contents as of November 2016. In December 2016, Google started promoting tie-ups for providing technologies by taking feasibility for launching onto markets into consideration.

<Reference> Overseas trends



<Reference> Overseas trends

Competitive and cooperative areas

- Automobile manufacturers are cooperating in research of globally-common ergonomics and law / infrastructure development. Moreover, European manufacturers are also promoting cooperation in maps and human resources for software engineering.
- If themes relating to Automated Driving are classified, it is found that European manufacturers are promoting cooperation particularly on themes of high development man-hours and costs regardless of the degree of difficulty of technology and efforts.