“Progress report on efforts to support the development of autonomous driving technologies and create adequate policies version 4.0.” Compiled by the Subcommittee on Business Discussions on Autonomous Driving Technologies

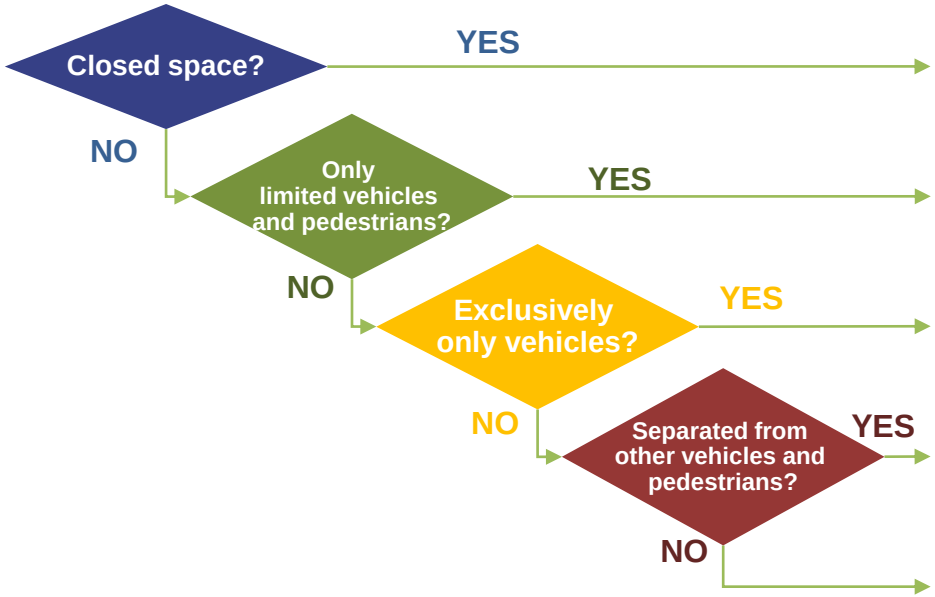
1. Introduction (outline of the subcommittee)

- Aiming to lead the world in the field of autonomous driving and contribute to solving social challenges, the subcommittee was inaugurated in February 2015 as a study group bringing together the Director-General of the Manufacturing Industries Bureau of the Ministry of Economy, Trade and Industry (METI) and the Director-General of the Road Transport Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). In FY2019, as one of its efforts needed to be discussed under the framework of All-Japan initiatives by the industry, academia and government sectors, the subcommittee studied and discussed; (i) the Roadmap for Deployment of Autonomous Driving Services, (ii) demonstration tests for sophistication of autonomous driving, and (iii) efforts for harmonization areas and published the discussion results as a report titled “Progress report on efforts to support the development of autonomous driving technologies and create adequate policies version.”

2. Roadmap for Deployment of Autonomous Driving Services (1)

- The Future Challenges WG summarized the traveling environments for autonomous driving into the following five basic types and complementary elements, based on hearings held with businesses and examples overseas.

Categorizing traveling environment



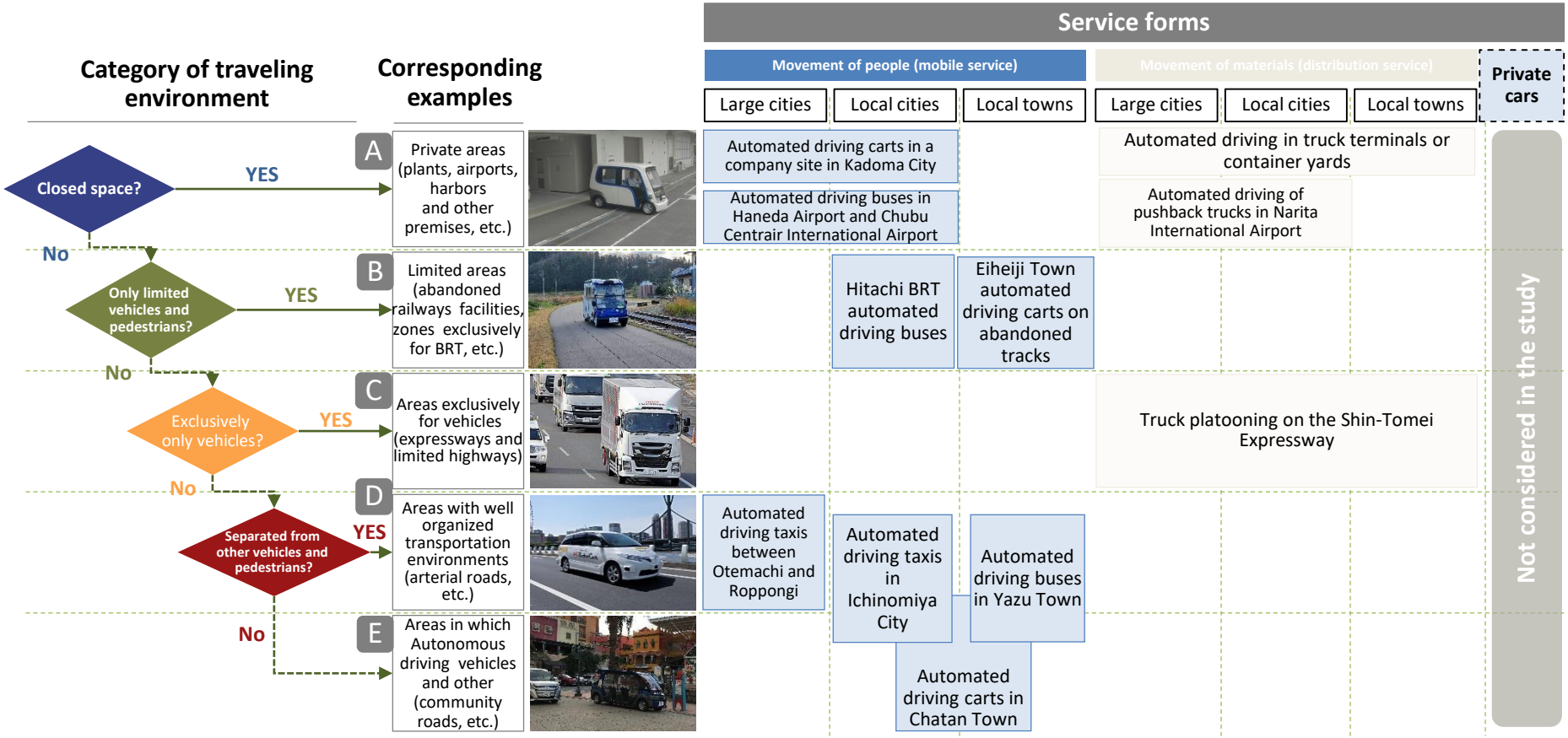
Corresponding types and their examples	Details
A **Private areas** (plants, airports, harbors and other premises, etc.)	• The area that is isolated from outside by a wall, gate, etc., and traffic within the site of the space is controlled
B **Limited areas** (abandoned railways facilities, zones exclusively for BRT, etc.)	• The area that is not isolated from outside but developed as an area where automated driving vehicles can run with the traffic of other vehicles and pedestrians being limited
C **Areas exclusively for vehicles** (expressways and limited highways)	• The area that is developed as an area where vehicles can exclusively run with the traffic of pedestrians being limited
D **Areas with well organized transportation environments** (arterial roads, etc.)	• The area where traffic lights are installed at intersections and the traffic of pedestrians and vehicles are separated while the traffic of oncoming vehicles is separated by a median strip, etc.
E **Areas in which Autonomous driving vehicles and other** (community roads, etc.)	• The area where the traffic of other vehicles and pedestrians are mixed, which does not fall under the categories mentioned above

* "A to E" only show basic types and do not necessarily indicate the order of difficulty because actual driving environment consists of various conditions such as those shown as complementary elements.

Complementary elements (Examples of main elements)						
Vehicle speed	• Automated driving speed (low speed / medium speed / high speed)	**Geographical features**	• Urban area / mountain area • Presence/absence of ups and downs • R (curvature of corner)	**Roads**	• Number of lanes, presence/ absence of sidewalks • Blurring of road marking • Road surface conditions (dry / wet / snow, etc.)
Environment	• Weather • Disaster situations • Follow light / backlight	**Traffic conditions**	• Traffic volume, traffic congestion • Presence/absence and volume of on-street parking • Presence/absence of obstacles	**Time of day**	• Daytime, nighttime

2. Roadmap for Deployment of Autonomous Driving Services (2)

- Examples of service forms applicable to each type of driving environment were determined through hearings held with businesses participating in demonstration experiments.



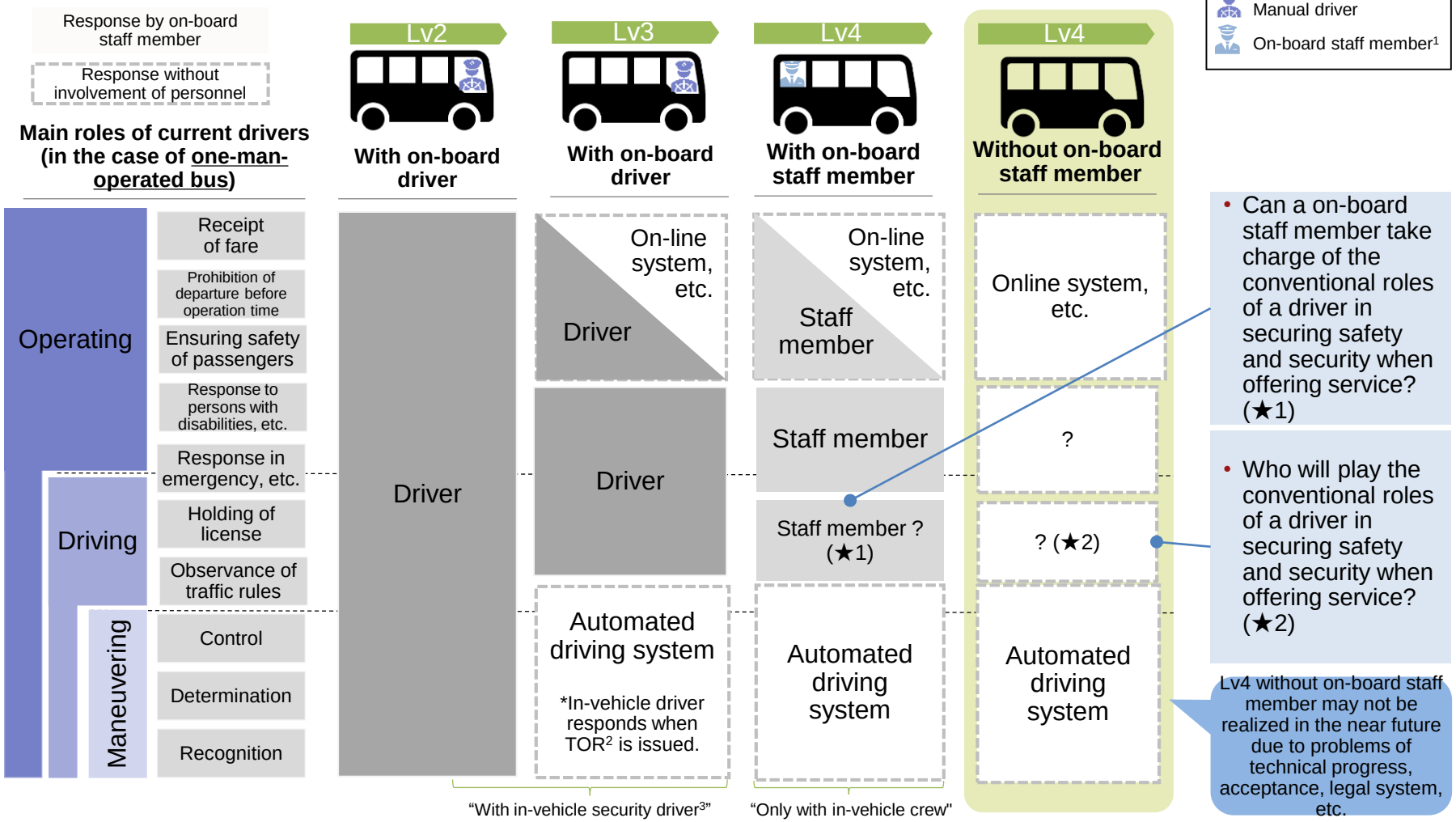
1. Each image illustratively shows a representative driving case and actual conditions may differ in each case.
   The difficulty of operating conditions of automated driving changes according to a combination of various elements including road conditions, infrastructure (hardware and software), interference with people or vehicles, and weather.

2. Roadmap for Deployment of Autonomous Driving Services (3)

- The changes that the advance of autonomous driving will bring in the players of the conventional roles of a driver are classified as images according to cases with and without a driver or staff member inside a vehicle.

Cases with a driver or crew inside a vehicle

Change in the main entities that play the roles of driver (image)



1. On board staff member: This person operates an Lv4 vehicle when it has broken down or the like, if necessary.
2. TOR (Take Over Request): The system issues the request for taking over the operation to the driver when the continuation of operation becomes difficult.
3. Although "hands-off" and "eyes-off" (in the case of Level 3) operation are performed when operating the vehicle using advanced automated driving systems, this refers to when the driver of the relevant vehicle is able to quickly perform driving operations when an emergency or TOR (Take-Over-Request) occurs. In other words, a "safety driver".

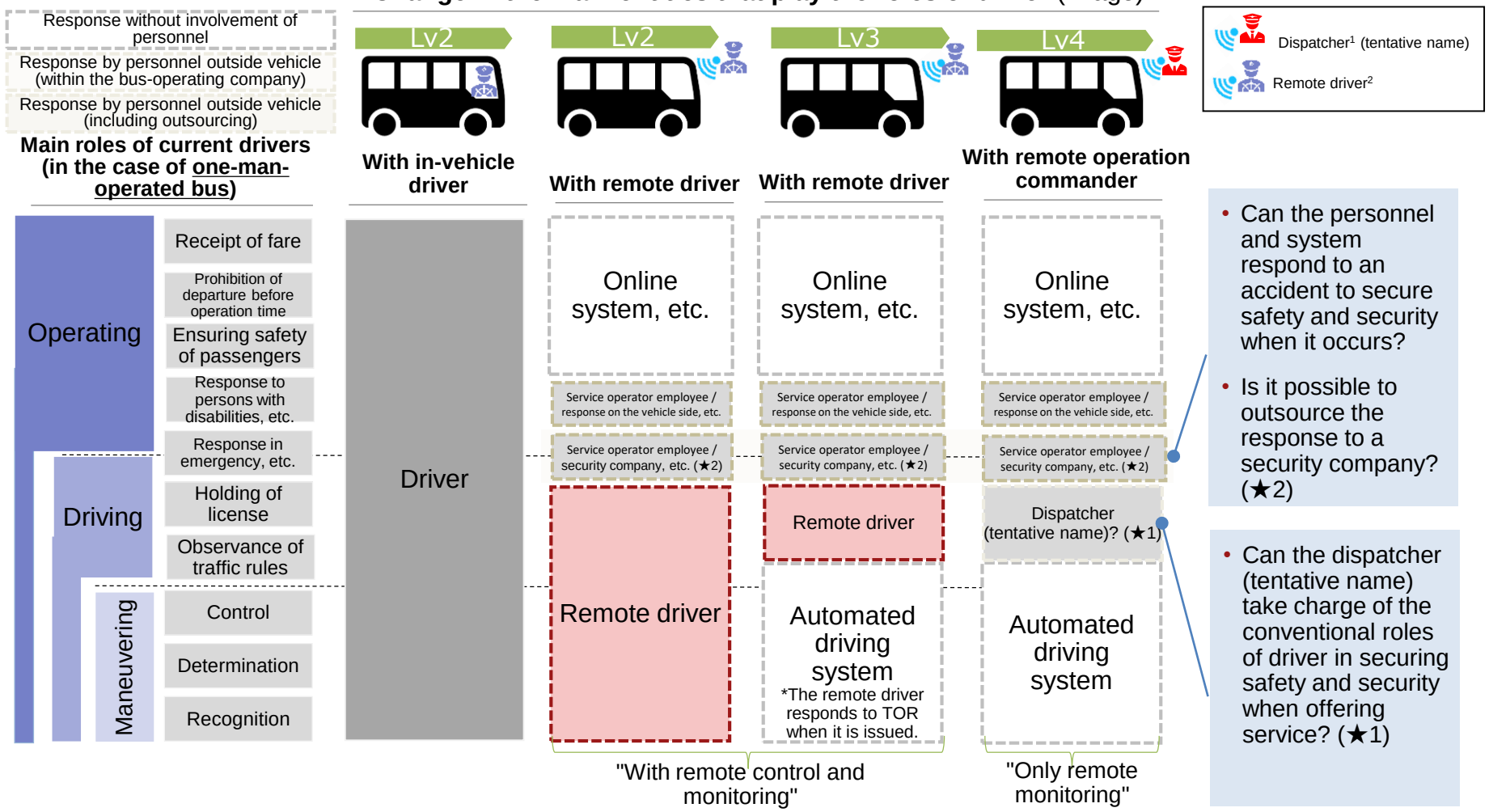
Note) Practically, there is a possibility of combining the presence of the driver or crew inside a vehicle and remote monitoring even within the same service.

2. Roadmap for Deployment of Autonomous Driving Services (4)

- For the cases without a driver or staff member inside a vehicle, the changes that the advance of automated driving will bring in the players of the conventional roles of a driver are classified as images.

Cases without a driver or crew inside a vehicle

Change in the main entities that play the roles of driver (image)

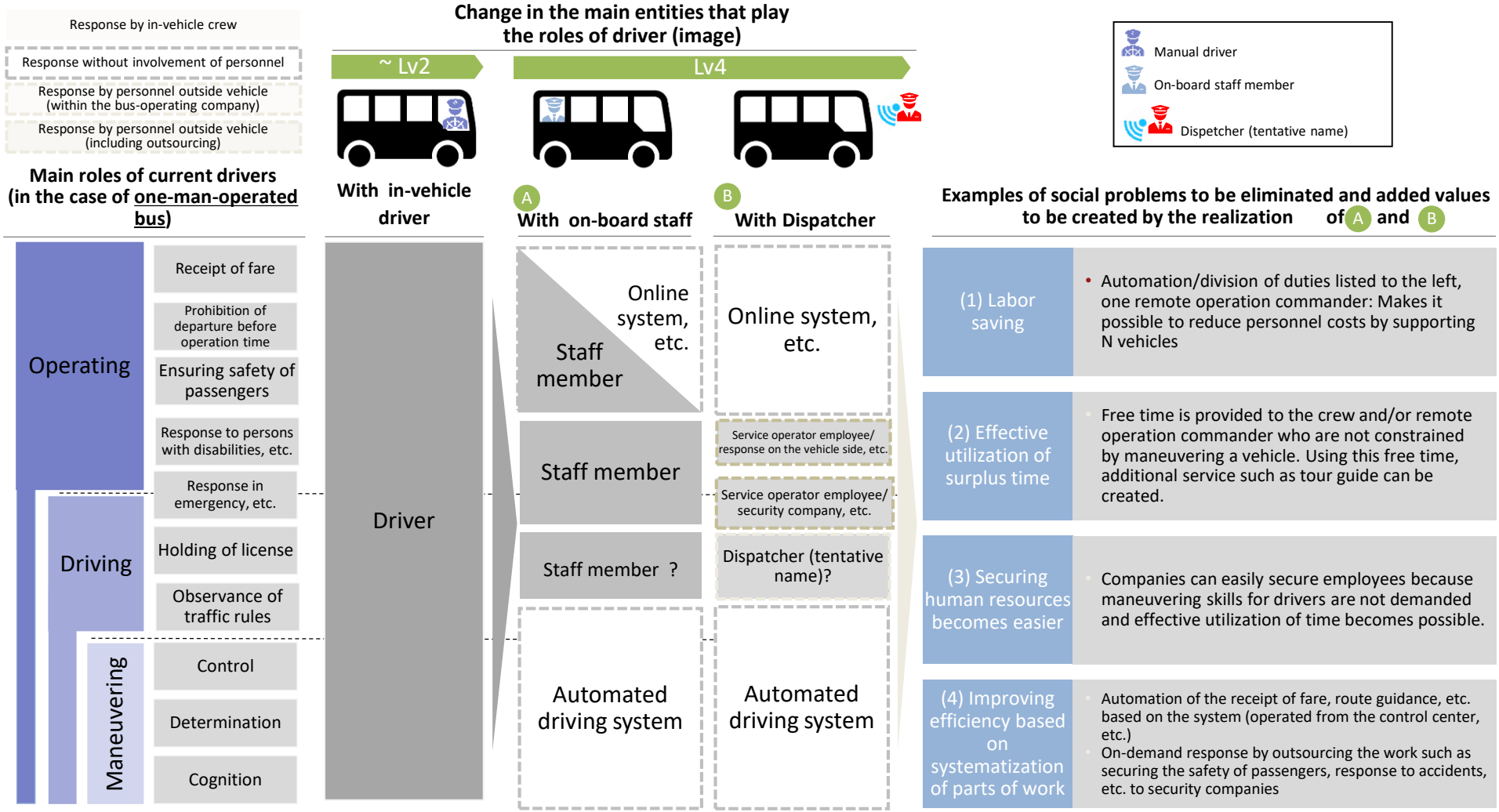


- Can the personnel and system respond to an accident to secure safety and security when it occurs?
- Is it possible to outsource the response to a security company? (★2)
- Can the dispatcher (tentative name) take charge of the conventional roles of driver in securing safety and security when offering service? (★1)

1. Dispetcher (tentative name): This person remotely operates an Lv4 vehicle when it has broken down or the like, if necessary.
2. Remote driver: This person remotely operates a vehicle as a monitor or operator (driver).
Note) Practically, there is a possibility of combining the presence of a driver or crew inside a vehicle and remote monitoring even within the same service.

2. Roadmap for Deployment of Autonomous Driving Services (5)

- New added values can be produced in mobile service when automated driving comes to share the roles of current drivers in the future.



2. Roadmap for Deployment of Autonomous Driving Services (6)

Category of traveling environment	Type of service	By the end of FY2019	Short term (from FY2020 to around FY2022)	Medium term (from FY2023 to around FY2025)	Long term (from around FY2026 onward)
A Reference: Private areas (plants, airports, harbors and other premises, etc.) — Low speed / medium speed	 • Mobility and transportation services within specific premises	(Demonstration test) • Technical demonstration using small carts, buses and other vehicles in several plants, airports, etc. (Kadoma City, which is undertaking such services, Haneda Airport, Central Japan International Airport, etc.)	**Remote monitoring only** • Starting **autonomous driving services operated only by remote monitoring in several plants, etc.** and then gradually expanding the ~~target~~ operational areas • Conducting **1:N remote monitoring**	• **Deployment of autonomous driving services operated only by remote monitoring in over ten plants, etc. in around FY2025** • **Increasing the number of autonomous driving vehicles ~~personnel~~ (N) operated by ~~in~~ remote monitoring of one personnel.**	
B Limited areas (abandoned railways facilities, zones exclusively for Bus Rapid Transit (BRT), etc.) — Low speed	 • Mobility services using small vehicles	(Demonstration test) • Long-term demonstration using small carts at abandoned railways facilities (Eiheiji Town) then expanding the operational area in sequence • Conducting 1:N remote operation and monitoring	**Remote operation and monitoring** • **Starting autonomous driving services with remote operation and monitoring in around one area** • Conducting **1:N remote operation and monitoring**	**Remote monitoring only** • Starting **autonomous driving services operated only by remote monitoring in several areas** • Conducting **1:N remote monitoring**	• **Deployment of autonomous driving services operated only by remote monitoring in over ten areas in around FY2025** • **Increasing N operated by remote monitoring**
Medium speed	 • BRT and shuttle bus services	(Demonstration test) • Technical demonstrations using buses in several areas (Hitachi BRT, Kesennuma-Line BRT, etc.)	**Conducted with one on-board safety driver** (on a regular basis or only for addressing "Take Over Request" (TOR)) • Starting **autonomous driving services with one on- board safety driver** • **(only for addressing TOR) in around one busway zone** • Operating such services with one on-board safety driver who also serves as a driver dealing with services other than TOR in other zones	**Only by remote monitoring or only with one on-board staff member** • Starting **autonomous driving services operated only by remote monitoring or with only one on-board safety operator in several areas** • Conducting **1:N remote monitoring for the services only with remote monitoring**	• **Deployment of autonomous driving services operated only with remote monitoring or with only one on-board safety operator in over ten areas in around FY2025** • **Increasing N involved in remote monitoring** • **On-board staff member provides customer services**
C Areas exclusively for vehicles (expressways and limited highways) — High speed	 • Transportation services by trucks using arterial roads	(Demonstration test) • Technical demonstration of trucks in a platoon with drivers in the second and following trucks and for systems for trucks in a platoon with no drivers in the second or following trucks (the Shin Tomei Expressway, etc.)	**Trucks traveling in a platoon with one on-board safety driver** (on a regular basis or only for TOR) • **Commercializing systems for operating a platoon of trucks with one on-board safety driver in FY2021**; After that, developing and commercializing these as newly developed systems (only for addressing TOR) ; and also promoting commercialization of systems for operating a platoon of trucks with no drivers in the second or following trucks • Connecting autonomous driving systems to infrastructures, e.g., those for road to vehicle communication, and promoting operational management of trucks	**Solitary on-board staff member (unmanned on some trucks)** • **Commercialization after FY2025** • Operating a platooning trucks with on-board staff member, sometime unmanned on following vehicles	
D Areas with well-organized transportation environments (arterial roads, etc.) — Medium speed	 • Taxi services in city areas • Bus services on arterial roads	(Demonstration test) • Technical demonstrations using taxis and buses in several areas (Odaiba, Minatomirai, areas around Kitakyushu Airport, etc.)	**With one on-board safety driver** (on a regular basis or only for addressing TOR) • **Starting autonomous driving services of buses and taxis with one on-board safety driver (on a then changing some of the services to those with one on-board safety driver (only for addressing TOR)** • Increasing the number of vehicles per area **from a few to ten or more**	**Only by remote monitoring or with only one on-board staff member** • **Starting autonomous driving services operated only by remote regular basis) and monitoring or with only one on-board staff member in several areas in around FY2025** • **Conducting 1:N remote monitoring** • **On-board staff member provides on-board customer services**	
E Areas in which Autonomous driving vehicles and other vehicles coexist (community roads, etc.) — Low speed	 • Mobility services using small vehicles	(Demonstration test) • Conducting demonstrations for autonomous driving in several areas (demonstrations in Chatan Town, roadside service areas, etc.)	**Remote operation and monitoring** • **Starting autonomous driving services with remote operation and monitoring in one area** and then expanding the operational areas in sequence • Conducting **1:N remote operation and monitoring**	**Remote monitoring only** • **Starting autonomous driving services operated only with remote monitoring in several areas** and then expanding the operational areas in sequence • Conducting **1:N remote monitoring**	• **Deployment of autonomous driving services operated only with remote monitoring in over ten areas in around FY2025** • **Increasing N involved in remote monitoring**
Medium speed	 • Last-mile taxi services • Feeder bus services	(Demonstration test) • Conducting demonstration tests using buses, etc. in several areas (regional cities, etc.)	**With one on-board safety driver** (on a regular basis or only for addressing TOR) • **Starting services of buses and taxis accompanied with one on-board driver and then changing some of the services to those with autonomous driving accompanied with one on-board safety driver (only for addressing TOR)** • Increasing the number of vehicles per area **from a few to ten or more**	**Only with remote monitoring or with only one on-board staff member** • Starting **autonomous driving services operated only by remote monitoring or with only one on-board staff member** from FY2026 and then expanding the operational areas in sequence	

Notes:
1. This roadmap was prepared by referring to the results of interviews with related businesses. Concerning the development of environments for achieving these goals, the ministries will hold discussions on appropriate timing and ideal approaches and carry them out bearing in mind future technological development and other perspectives.
2. The term "starting [autonomous driving] services" refers to conducting businesses, e.g., transportation, in a continuous manner by gaining a certain amount of revenues (not limited to freight revenues from passengers and including indirect burden of expenses that municipalities, private companies and other entities bear).
3. Consideration of the timing for achieving unmanned autonomous driving services in the respective categories is handled differently depending on a variety of conditions, e.g., weather and traffic volumes in the target traveling environments.

Examples of measures for accelerating achievement of unmanned autonomous driving services and expanding the service-provided areas

[i] Developing cooperation and reaching consensus with local residents (demonstrating caution in running vehicles with autonomous driving systems)
ii. Connecting autonomous driving systems to infrastructures at intersections, boarding and alighting points, etc. (providing such systems with signal information, developing departure and arrival points exclusively for target vehicles, etc.)
} Developing traveling environments through these efforts
iii. Autonomous driving services in which drivers remotely control the vehicles for specific zones where operation only by remote monitoring is difficult, e.g., intersections and boarding and alighting points

3. Demonstration Tests for Sophistication of Autonomous Driving

* Only METI and MLIT projects are explained here.

1. Demonstrations for mobility services using autonomous driving;

Goal: Deployment of driverless autonomous driving mobility services in FY2020

Small electric-cart models: Eiheiji Town, Fukui Prefecture, and Chatan Town, Okinawa Prefecture

- Based on the results of the long-term demonstration over six months, METI and MLIT confirmed seasonal variations, changes in demand by day of week and other situations (for discussing development of bus schedules).
- The ministries developed vehicular technologies based on the results of the long-term demonstration and other efforts (for improving recognition technology, etc.).
- They will conduct demonstrations for and assessment of: out-of-service operation of unmanned vehicles and operation of three or more vehicles by one remote operator.

Bus models: Hitachi City, Ibaraki Prefecture; Otsu City, Shiga Prefecture; Yokohama City, Kanagawa Prefecture; Sanda City, Hyogo Prefecture; and Kitakyushu City and Kanda Town, Fukuoka Prefecture

- The ministries changed the target buses from small buses to mid-sized buses to improve business feasibility and developed two mid-sized buses with autonomous driving systems.
- They selected five transportation businesses as operators of demonstration tests using mid-sized buses with autonomous driving systems in October 2019. In response, the selected businesses have begun preparations for demonstration tests which will start from FY2020.
- One of the businesses conducted a pre-demonstration test using small buses (in one area) for about one month in February 2019 and successfully completed the test with no accidents.

2. Demonstration test for operating truck platooning;

Goal: Achieving technologies for operation of truck platooning with no drivers in the second or following trucks on expressways in FY2020

[System for truck platooning with no drivers in the second or following trucks]

- The ministries demonstrated operation of target trucks by expanding the distances of test operation and in a variety of road circumstances (night operation, tunnels, etc.) and confirmed that the system successfully worked showing no troubles.
- They developed technologies to make the system meet the requirements for electronic towing technologies and demonstrated operation of truck platooning with no drivers in the second or following trucks on a test course.

[System for truck platooning with drivers in the second and following trucks]

- Toward commercialization of the system, they conducted a demonstration in which a large vehicle merged into the space between target trucks during night-time operation of the truck platooning and found that trucks in a platoon tend to travel in a more stable manner during the night.

4. Efforts for Harmonization Areas, etc.

Efforts in FY2019
Efforts in FY2020 onward

Harmonization areas	Ideal goals to be achieved and polices for efforts
I. Maps	Aiming to develop highly-accurate maps in a quick manner tailored to the timing of commercialization of the systems in order to enhance the performance of estimating and recognizing the current position of drivers' vehicles; developing maps of expressways by FY2018, **developing data on the maps updated as needed and providing updated data; promoting discussions on and preparations for development of maps of state-run national roads as public roads**; and **deciding on policies for developing maps of specific regions by 2021 and continuing to promote dissemination of such maps to other countries and cost reduction through developing automated mapping, etc.**
II. Communication infrastructures	Aiming to improve the safety of autonomous driving by being coordinated with communication infrastructure technologies as well as improving autonomous vehicle technologies in order to achieve sophisticated autonomous driving as early as possible, **in FY2019, having developed ITS roadside units, etc. for providing drivers with signal information and other purposes and started demonstrations bringing together 29 organizations, e.g., automobile manufacturers at home and abroad, as part of the demonstration test in the Tokyo Waterfront Area**; and **promoting discussions on international harmonization and standardization as well as sharing of the results of demonstrations under industry-academia collaboration in the future**.
III.Recognition technology IV.Decision-making technology	Developing test courses which can reproduce traveling environments that may appear on actual roads as an effort for improving the efficiency of development of the technologies; **having been collecting data contributing to discussions on indices of transportation infrastructures, which are minimum requirements for the Levels 3 and 4 Autonomous Driving Technologies, and on performance of recognition and judgment technologies as part of the demonstration test in the Tokyo Waterfront Area** taking advantage of the open research framework in universities under the Second Round of the Cross-ministerial Strategic Innovation Promotion Program (SIP) organized by the Cabinet Office (CAO); and **determining the indices and performance in around FY2020**.
V. Ergonomics	**Having been promoting international standardization for a variety of requirements and other criteria with an eye on global development of ergonomics for drivers**, based on the physiological and behavioral indices of drivers and the fundamental concepts of driver monitoring systems and in light of the assessment results of the large-scale demonstration test as part of the CAO First Round of SIP conducted from FY2017 and FY2018 as well as **the efforts conducted under the CAO Second Round of SIP**; and **continuing to advance these efforts**.
VI. Safety	Establishing methods of assessing events caused by accidents involving vehicle systems, etc., performance limits and misuse; in FY2018, having prepared a handbook explaining past lessons and case examples as a reference for use by a wide variety of people; and having been promoting efforts to encourage the public to make use of the handbook since FY2019.

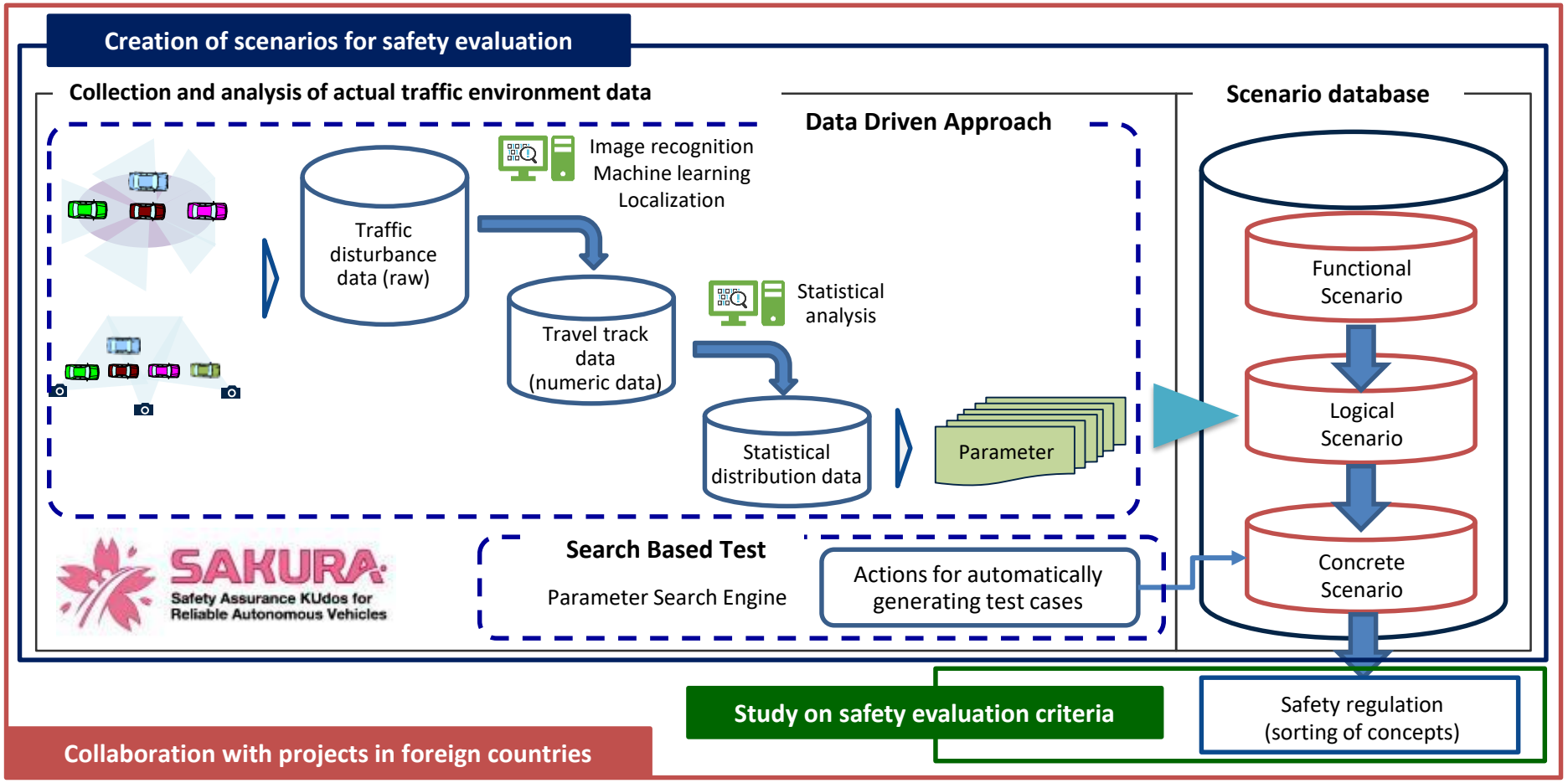
4. Efforts for Harmonization Areas, etc.

Efforts in FY2019
Efforts in FY2020 onward

Harmonization areas	Ideal goals to be achieved and polices for efforts
VII. Cybersecurity	To ensure safety and aiming at harmonization of development and assessment methods in order to improve the efficiency in development of functional safety; **in FY2019, having utilized an assessment environment (test bed) constructed under the FY2018 project in research and other programs of the National Police Academy**; **promoting further utilization of the environment in around FY2020; and advancing discussions on enhancement of information-sharing systems and establishment of a framework for cyber-physical security measures** in the future.
VIII. Human resources with expertise in the field of software	Aiming to promote discovery, securing and fostering of human resources with software expertise in order to overcome shortages of such human resources in the field including cybersecurity, a core element for developing software; **cultivating programs for fostering human resources satisfying the Skill Standards formulated in FY2018** and **aiming to have the programs certified as those under the Program for Certifying IT-Skill Training Courses to Meet the Era of the Fourth Industrial Revolution in around FY2020; and continuing to hold competitions in recognition accuracy and other measures of performance of vehicles in autonomous driving on test courses and promoting introduction the competitions into international events**.
IX. Social acceptability	Addressing issues related to accidents that are unique to autonomous driving in terms of compensation for victims, pursuing responsibility and investigating causes involving such accidents; **in FY2019, having described the liability related to autonomous driving, i.e. property damages and updating of software; having been raising public awareness of key points that people need to recognize and implement concerning autonomous driving through symposiums and other events in parallel with confirming public opinions and the level of people's understanding by conducting world cafés style workshops, questionnaire surveys and using other means as efforts for encouraging public understanding of autonomous driving technologies as users and for fostering public acceptance of such technologies**; and **continuing to advance these efforts**.
X. Safety assessment	Considering it necessary to formulate new approaches to safety assessment tailored to autonomous driving systems' operation of vehicles, which are additional approaches to the conventional approaches to safety for vehicles driven by people; **having discussed preparing a scenario explaining Japan's traffic environments for expressways and submitting it as Japan's proposal for new international standards to the International Organization for Standardization (ISO) in collaboration with other member countries; having discussed ideal approaches to a scenario on public roads and also discussed a framework to advance development of approaches to safety assessment in a continuous manner; as part of the CAO Second Round of SIP, having started building environments for assessing in virtual spaces created by computer simulations for safety assessment, which requires enormous data for developing vehicles with autonomous driving systems**; and **continuing to advance data collection and analysis and activities for international standardizations of such safety assessment**.

<Reference> x. Safety Evaluation [1]

- Decided to start activities for developing safety evaluation technology at the Panel on Business Strategies for Automated Driving
- Agreed to create scenario data on a trial basis from the use cases prepared collectively by automobile manufacturers to enhance the safety evaluation technology of automated driving vehicles. Companies have cooperated in promoting the SAKURA* project for developing scenario creation process for safety evaluation on the basis of actual traffic flow observation data, since FY2018.
- Promote the SAKURA project through collaboration with the safety evaluation projects in foreign countries including the PEGASUS project in Germany



* SAKURA : Safety Assurance KUdos for Reliable Autonomous Vehicles

<Reference> x. Safety Evaluation [2]

- Inputted the results of Japan's SAKURA project actively into international academic conferences and meetings to strengthen collaborations with foreign countries.
- Contributed to international standardization in cooperation with the organizers of safety evaluation projects in overseas countries.

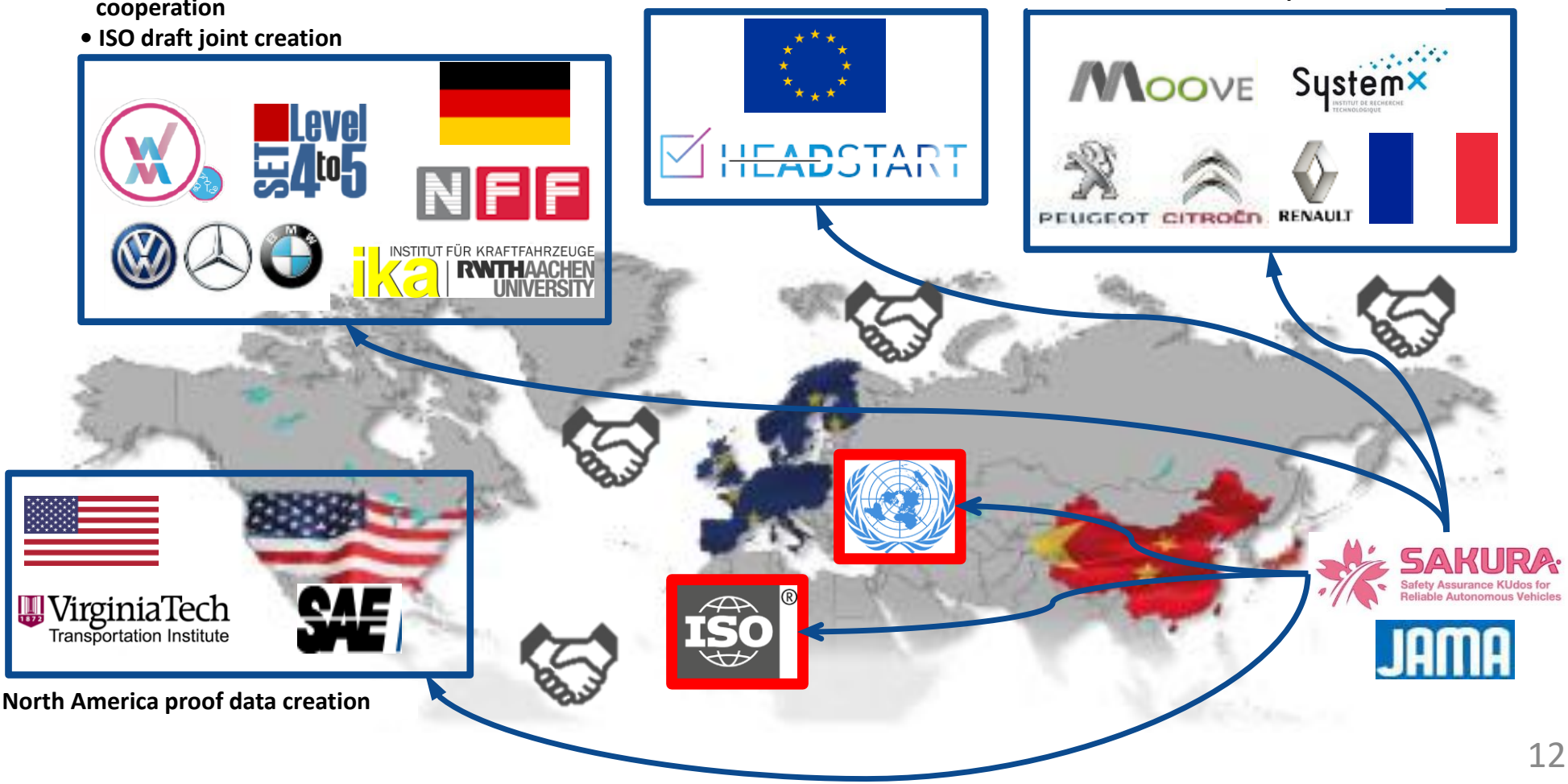
(March 2017) Japan-Germany Hannover Declaration

- **Scenarios and proof system cooperation**
- **ISO draft joint creation**

- **Grasp of harmonization trends in Europe**

(September 2019) Concluded the memorandum of cooperation concerning automobile industries between Japan and France

- **Scenario database cooperation**



- **North America proof data creation**