Cross-Ministerial Strategic Innovation Promotion Program / Innovation of Automated Driving for Universal Services (SIP-adus)

Analysis of social and industrial aspects involved in the effort to develop more advanced automated driving systems and ensure their widespread use, as part of the investigation and study of the various issues that must be resolved to achieve automated driving systems and the approach to the resolution of these issues

Summary

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Institute of Industrial Science, The University of Tokyo

ITS Center
THE UNIVERSITY OF TOKYO
次世代モビリティ研究センター

Background to study / content of study

- Background to study
  - The following will be needed in order to develop more advanced automated driving (AD) systems and ensure their widespread use:
    - Clarification of the domestic and international impact on society and industry and the risks that will result from changes, as well as measures to mitigate impact and risks, and formulation of scenarios from a long-term perspective
    - Greater understanding of AD systems on the part of the general public
- Content of study
  - Study of advancement and dissemination of AD systems, based on social and industrial impact, in preparation for the introduction of AD systems
  - Study in preparation for the establishment of a mechanism for industry, government and academic cooperation

List of study team's members

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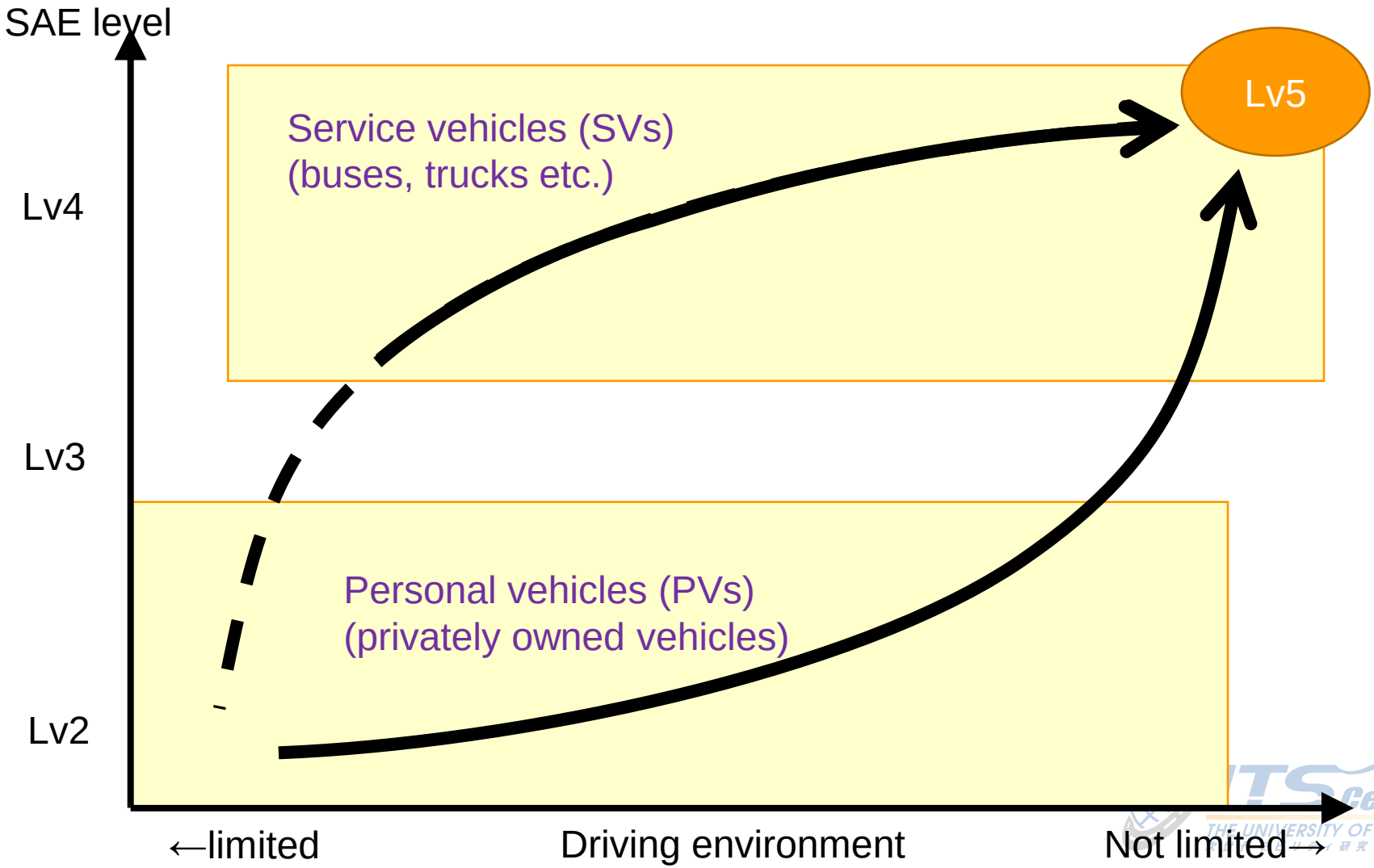
○ Chairperson

Progress scenario in the development of AD system technologies (Based on FY 2016 achievements)

- The development of AD system technologies will evolve at two levels.



Definition of PVs and SVs

	Flow of people	Flow of materials	Other
Personal vehicles (PVs)	・Privately owned vehicles ・Company vehicles ・Official vehicles ・Ride sharing (friends and acquaintances)	–	–
Service vehicles (SVs)	・Buses ・Taxis ・Car sharing ・Rental cars ・Ride sharing (business) Public transport systems	・Trucks ・Garbage trucks (reverse logistics) Logistics systems	・Snow plows ・Street sweepers ・Tunnel sweepers ・Road patrol vehicles (• Police cars) (• Fire trucks) (• Ambulances)

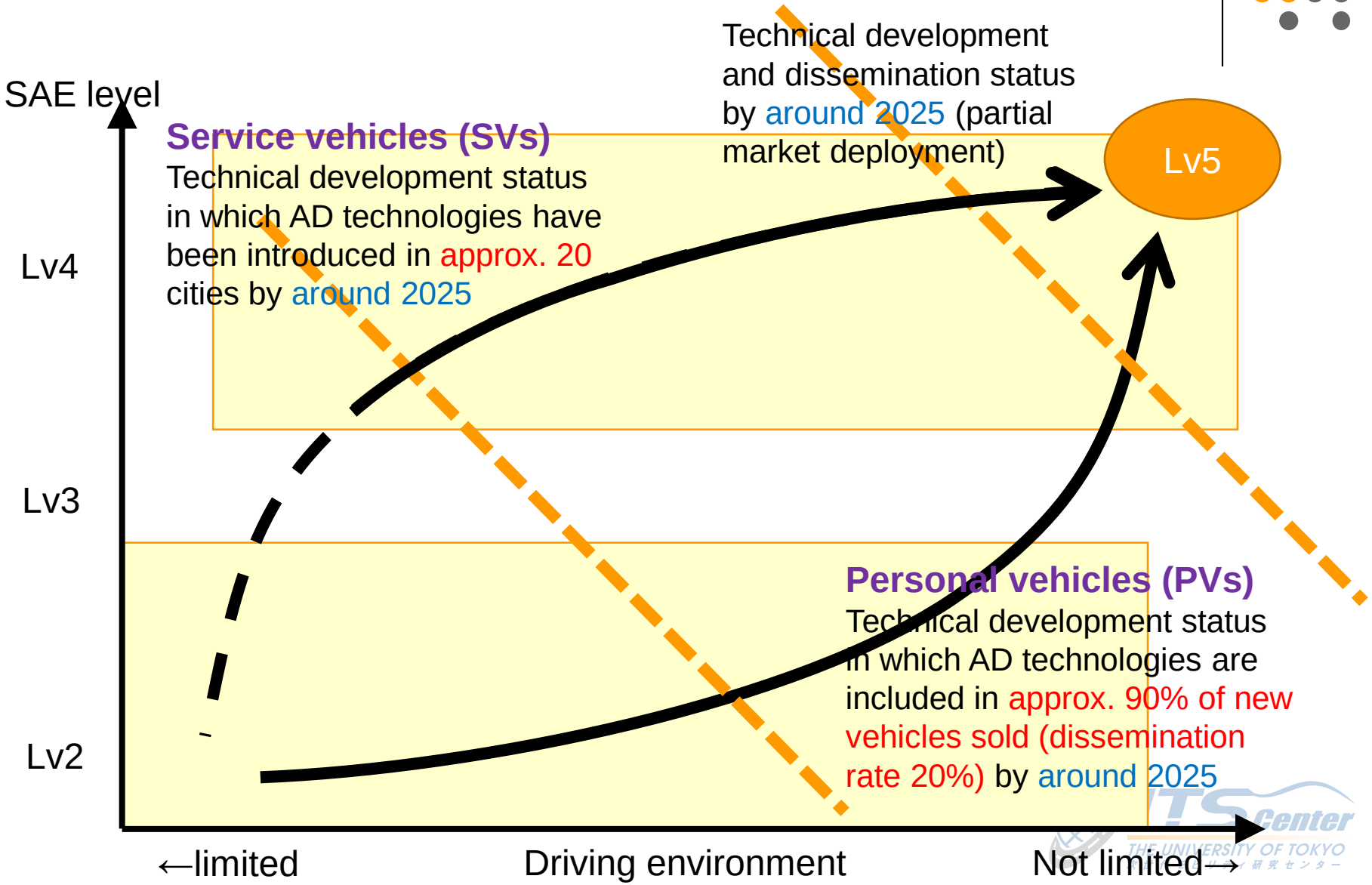
Future vision for AD systems (proposed) Preconditions for study

- The timeline is divided into two sections: near future (around 2025) and more distant future (latter half of the 2030s).
- Assumptions are made regarding the status of technical development and dissemination as well.

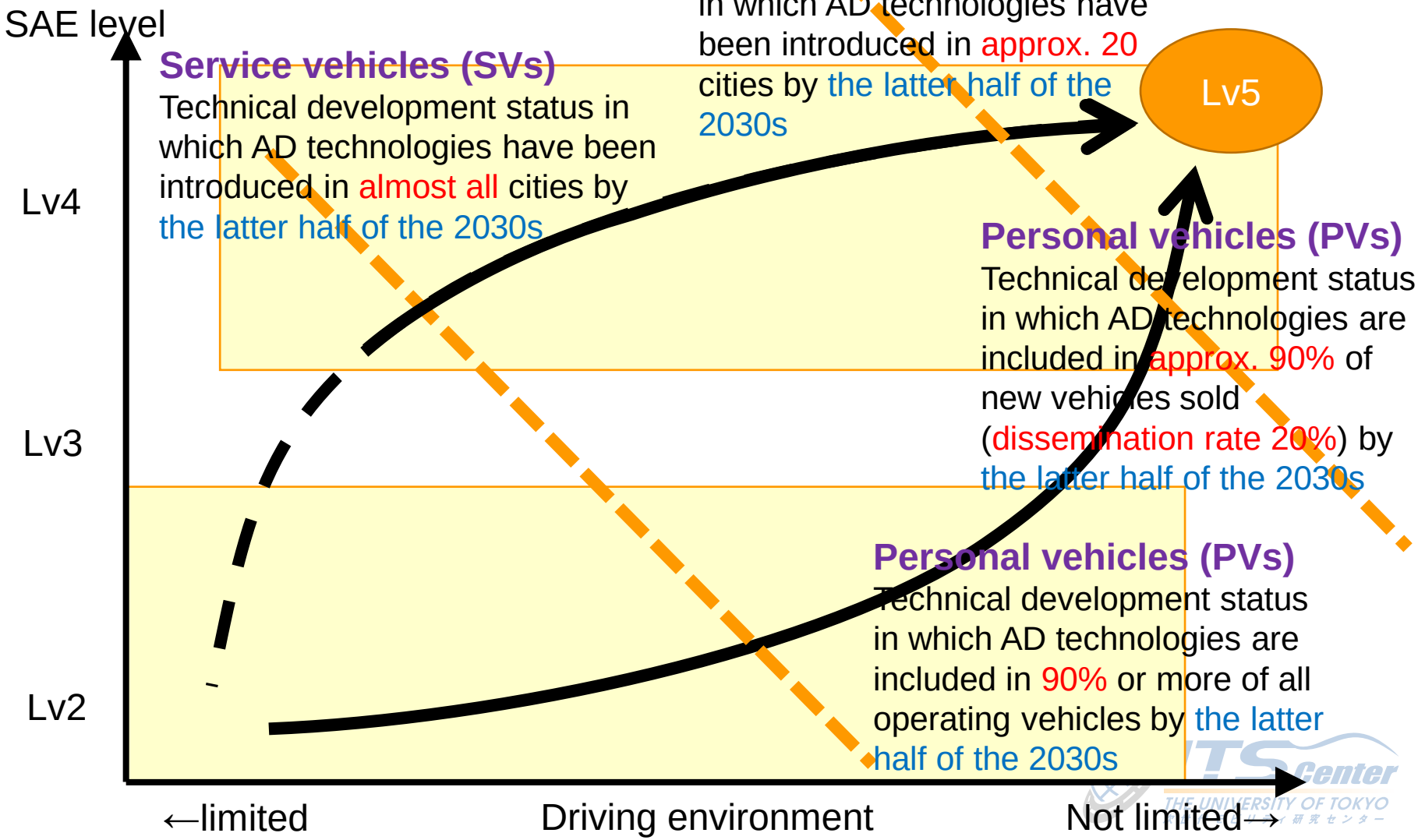
- Around 2025
  - Personal vehicles
    - Some Lv2 AD technologies are expected to be included in approximately 90% of new vehicles sold (dissemination rate 20%*).
  - Service vehicles
    - Lv4 vehicles will be introduced for both public transport and logistics vehicles in limited areas and on dedicated roads and lanes in a number of cities (approximately 20). Platoon driving will be possible on expressways using electronic coupling.
- Latter half of 2030s
  - Personal vehicles
    - Lv4 AD technologies are expected to be included in approximately 90% of new vehicles sold (dissemination rate 20%*)
  - Service vehicles
    - Public transport and logistics vehicles will be equipped with Lv4 AD technologies in almost all cities.

* Results of estimates in the Cross-Ministerial Strategic Innovation Promotion Program (SIP) / Automated driving system "Development and verification technologies for visualizing global transport CO2 emissions" project

Establishment of technical development and dissemination status by around 2025 (proposed)



Establishment of technical development and dissemination status by latter half of 2030s (proposed)



Societal needs/challenges

☐ Societal needs are categorized from the perspective of road traffic issues, public transport systems and logistics systems

- Road Traffic issues
  - Measures to reduce traffic accidents
  - Measures to reduce traffic congestion
  - Measures to reduce environmental load
- Public transport systems
  - Ensuring mobility for vulnerable transport users (senior citizens, physically disabled, young people)
  - Measures to alleviate the shortage of public transport drivers and reduce operating costs, and ways to improve profitability of public transport operators
  - Improving the level of service (LOS) in public transport
- Logistics systems
  - Measures to alleviate the driver shortage and reduce logistics costs

→Description in detail about future vision and matters to be implemented, taking public transport system (ensuring mobility for vulnerable transport users) and logistics systems as examples

Future vision from the standpoint of societal needs and matters to be implemented (Public transport systems [1]) (Proposed)

- Societal needs
  - **Ensuring mobility for vulnerable transport users (senior citizens, physically disabled, young people) (when users drive themselves)**
- Technical development scenario
  - Lv2 personal vehicles with advanced driving safety support, provided by means of restriction-relaxed licenses that enable users from young people to senior citizens to drive (by around 2025)
- Societal impact
  - Increased opportunities and expanded environment for driving oneself by means of restriction-relaxed licenses, and improved health by driving oneself
- Negative impact / issues
  - Need to establish restriction-relaxed licenses (capacity assessment)
- Issue resolution scenarios
  - Establishment of requirements for restriction-relaxed licenses (capacity assessment) *[primarily government]*
  - Establishment of new systems for licensing and training *[primarily government]*
  - Obligation of people who do not meet restriction-relaxed license requirements to surrender license *[primarily government]*

Future vision from the standpoint of societal needs and matters to be implemented (Public transport systems [2]) (Proposed)

- Societal needs
  - **Ensuring mobility for vulnerable transport users (senior citizens, physically disabled, young people) (in cases in which they do not have driver's licenses)**
- Scenarios for progress in technical development
  - Low-speed, small group transport service (Lv4, limited routes, dedicated area Lv4) (by around 2025)
- Societal impact
  - Ensuring mobility, regional stimulation, emergence of mobility providers and other platform providers etc.
- Negative impact and issues
  - Need to ensure societal acceptance for Lv4 vehicles
  - Need to construct the infrastructure required for Lv4 vehicles, clarify maintenance standards and devise measures for early deterioration
  - Need to establish social systems relating to Lv4 vehicles, such as legal and insurance systems
  - Need to organize requirements for establishment of business models, etc.
- Scenarios for issue resolution
  - Promotion of public understanding and societal acceptance of Lv4 vehicles *[industry, government, society and academia]*
  - Study of infrastructure requirements for Lv4 vehicles *[industry, government and academia]*
  - Study of legal systems and insurance systems for Lv4 vehicles *[industry, government and academia]*
  - Fee structure for business establishment and assessment of corporate structure from the standpoint of social welfare and social efficiency *[primarily industry and academia]* etc.

- Lv4/Lv5 individual use of car sharing type self-driving vehicles, use of on-demand type and patrol type Lv4/Lv5 services for small group joint ridership (latter half of 2030s)
- Return to compact cities, concern for increased costs throughout society as a whole, etc.
- Reassessment of urban transport strategies to add AD technologies, including road charges and tax systems *[primarily government]* etc.

Future vision from the standpoint of societal needs and matters to be implemented (Logistics systems) (Proposed)

- Societal needs
  - **Measures to resolve the driver shortage and reduce logistics costs**
- Scenarios for progress in technical development
  - Platooning and electronic coupled driving on expressways (following vehicles unmanned) (by around 2025)
- Societal impact
  - Improvement of driver shortage situation, reduction of logistics costs, high-efficiency logistics, reorganization of business scheme
- Negative impact
  - Need for Establishment of environment (requirements for restriction-relaxed licenses, legal status of electronically coupled vehicles, securing of locations for forming electronic coupling, status in terms of labor management etc.)
  - Need to carefully assess conditions for establishment of business models
  - Need to increase acceptance on the part of drivers of surrounding vehicles, etc.
- Scenarios for issue resolution
  - Environment establishment *[industry, government and academia]*
  - Study of establishment of business models *[industry, government and academia]*
  - Study of HMI with surrounding vehicles (including need to establish standards) *[primarily industry and academia]* etc.

→
- Wide-area unmanned (Lv4/Lv5) (latter half of 2030s)

→
- Need to carefully assess new costs (maintenance, operation, tax systems and fee systems)
- Need for advanced management of people and goods (including study of redeployment of logistics facilities) etc.

→
- Study of costs, tax systems and fee systems *[primarily industry and academia]*
- Study of advanced management for people and goods *[primarily industry and academia]* etc.

Measures for automobile industry

- Negative impact and issues
  - Structural changes to automobile manufacturing and automobile repair business, etc. (creation of worldwide de facto standards will proceed and more and more companies will be weeded out)
  - Automobile technological changes and changes in sales volumes will affect the entire structure of manufacturing in Japan
- Scenarios for issue resolution
  - Organization of a strategic task force to consider next-generation mobility ecosystems *[primarily government-endorsed academia + industry]*
    - Establishment of an organization for reconciliation of interests, primarily by academia, to create areas for cooperation (along the lines of Acatech, the German Academy of Science and Engineering, etc.)
  - Strategic compliance with international standards *[primarily government and academia]*
  - Personnel training for software engineers (system architects)
    - Promotion of OTA (Over-The-Air) related research and development *[primarily industry and academia]*
    - Development of technologies for defense against cyberattacks *[primarily industry and academia]* etc.

Policy assessment indicators (KPI) relating to AD systems (preliminary draft)

- KPI to show the progress in the evolution/practical application of AD systems
  - Status of technology dissemination (Lv2 and Lv4)
    (e.g. number of vehicles sold, etc.)
  - Status of technology advancement and expansion of driving environments of AD systems
    (e.g. number of revisions and additions to relevant laws and standards with the aim of disseminating AD systems)
  - Status of practical application of services (platooning driving, the “last mile” etc.)
    (e.g. Number of locations where practical application of services has occurred)

Policy assessment indicators (KPI) relating to AD systems (preliminary draft)

- Follow-up items to ensure that evolution/practical application is significant
  - Overall
    - Increase in social acceptance
      (e.g. Number of field testing and practical application locations, etc.)
    - Increased use of sharing services
      (e.g. Number of sharing service users, use vehicles etc.)
    - Achievement or creation of new services
      (e.g. Number of companies engaged in new business, etc.)
    - State of change in automobile manufacturing
      (e.g. shift to a horizontally distributed model, etc.)
  - Public transport systems
    - Percentage of population covered by next-generation public transport*
    - Profitability (income / costs) of public transport operators that have introduced AD systems
    - Number of users of next-generation public transport*
    - Percentage of senior citizens and other vulnerable transport users venturing out into society, etc.
  - Logistics systems
    - Driver driving time (amount of reduction)
    - Logistics system CO2 emissions (amount of reduction) etc.

* "Next-generation public transport" refers to public transport consisting not only of conventional rail, bus, etc. public transport but also car sharing services and low-speed shuttle buses and so on that use AD systems.

Estimate of effectiveness in reducing traffic accidents

※ For all roads including residential roads

- It is assumed that accidents in which an automobile is the primary entity involved (≒ originator of the accident) will be reduced to zero, while accidents in which an entity other than an automobile such as a motorcycle, bicycle, pedestrian etc. is the primary entity involved will continue to occur, and the effect is estimated to be a reduction in traffic fatalities.

Table Number of traffic fatalities by type of traffic accident and primary entity involved (FY 2014)

Type of accident	Automobile	Motorcycle	Moped	Bicycle	Pedestrian	Other	Unknown	Total
Person and vehicle	1,273	26	10	8	151		6	1,474
Vehicle and vehicle	1,210	117	92	134		1	4	1,558
Single vehicle	638	151	53	113		3		958
Train	13	1	1		23			38
Total	**3,134**	**295**	**156**	**255**	**174**	**4**	**10**	**4,028**

Source: Traffic Statistics (FY 2015 edition)

The number of accidents in this section is estimated to decrease as a result of the dissemination of automated driving systems.

Effectiveness in reducing traffic accidents involving fatalities

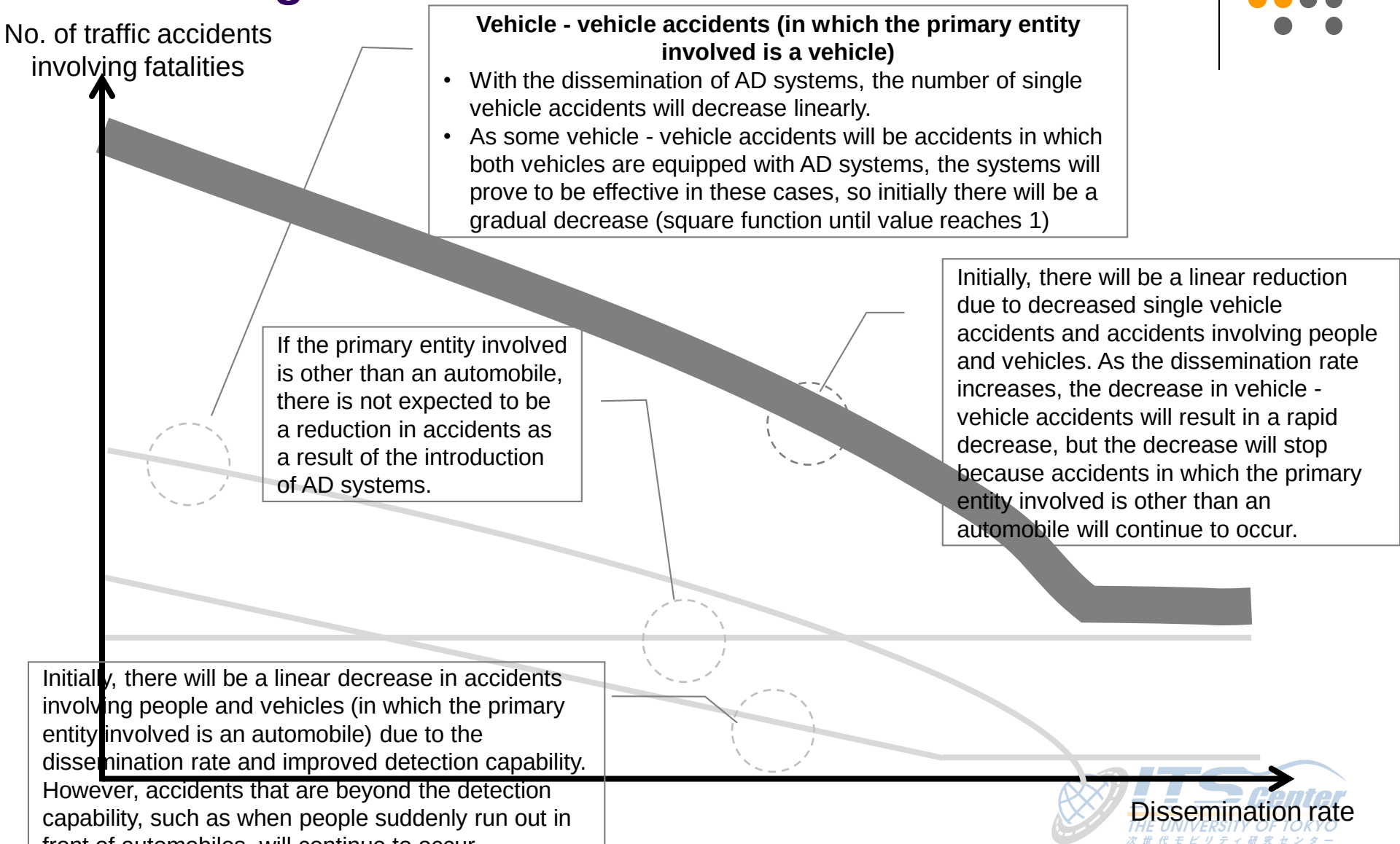
※ For all roads including residential roads

- The number of traffic accidents involving fatalities will be reduced by 3,143 as a result of the introduction of AD systems. This will produce a reduction effectiveness of 78% as compared to before introduction.

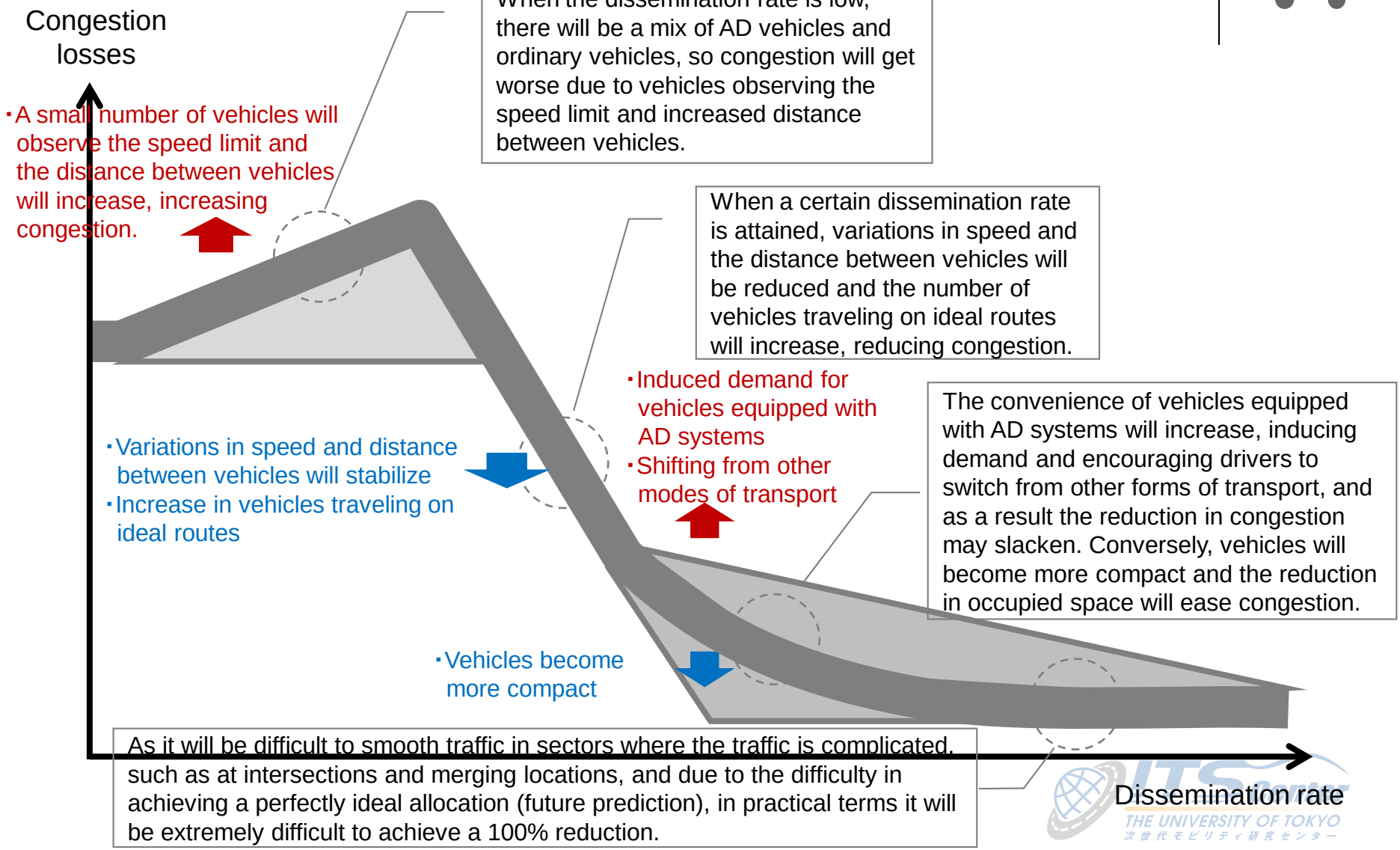
	Primary entity automobile	Primary entity other than automobile	Total
Prior to introduction of AD systems (no. of accidents)	3,134	894	4,028
After introduction of AD systems (no. of accidents)	>0*	894	>894
Amount of reduction of accidents involving fatalities (no. of accidents)	<3,134	0	<3,134
Effectiveness in reducing accidents involving fatalities	<100%	0%	<78%

* However, as accidents that are beyond the capabilities of detection, primarily accidents involving people and vehicles, are expected to continue to occur, so in practical terms it will be extremely difficult to reduce the number of accidents to zero.

Relationship between dissemination rate of AD systems and number of traffic accidents involving fatalities



Relationship between dissemination of AD systems and congestion losses



Specific matters for execution in preparation for the implementation of AD systems
– Fields for industry, government and academic cooperation – (proposed)

- **Human factor** (indispensable for implementation of AD)
  - HMI and determination of readiness status
  - Relationship with external HMI, societal acceptance (including publicity activities), societal norms and ethics
  - Determination of driving capability (medical evaluation)
  - Traffic safety education and awareness (understanding of the capabilities of AD vehicles and relationship to society and oneself)
- **Cooperation on infrastructure, urban planning and mobility support** (collaboration with society)
  - Cooperation on road network management, regional stimulation and mobility support activities
- **Technologies for unmanned cargo transport** (contribution to economic activities)
  - Cooperation with respect to robot technologies and drone technologies
  - Reverse logistics
- **Legal systems and insurance systems**
  - Societal rules (to establish an environment for promoting dissemination)
  - Social safety net (for victim relief, etc.)

Important points for discussion for the implementation of AD systems
– Need for discussion based on industry, government and academic cooperation – (proposed)

- Discussion of **diversification** and **integration** of transport modes
  - Reconstruction of public transport system in cities, regions and national land
    - Diversity of public transport operator (AD vehicles of car sharing and ride sharing are also public transport)
    - Relationship to the trend away from ownership of private vehicles and toward vehicle sharing as a result of the IoT
  - Discussion on ideal transport systems in the future in cities, regions and national land
    - Discussion on transport mode applied AD systems (e.g. feeder trips), understanding pros and cons of AD systems
    - Collaboration with city, regional and land planning (Status of AD system in a transport strategy and transport master plan)

Important points for discussion for the implementation of AD systems
– Need for wide-ranging cross-sectoral industry, government and academic cooperation – (proposed)

- Cooperation with a wider array of relevant entities (**establishment of ecosystem**)
  - Establishment of organizations to create ecosystems
  - Collaboration that goes beyond existing industry frameworks (business ecosystem)
  - Cooperation between universities in Japan and overseas (cooperation among academia including cultural and social sciences, medicine, and cooperation among organizations) and creation of learning systems
  - International cooperation (fostering of international mutual understanding)
  - Cooperation among industry, government and academia (indispensable)

Reference

Measures to resolve road traffic issues (traffic accidents) (proposed)

Category	Item		
Societal needs	Measures to reduce traffic accidents		
Scenarios for progress in technical development	Lv2 on expressways and ordinary roads (reduction of driver load through driving assistance technologies)	➔	Lv2 and Lv4/Lv5 on expressways and ordinary roads (elimination of human factor in traffic accidents and balance of driver involvement)
	Reduced speeds in limited areas		
Societal impact	Reduction of traffic accidents		
Negative impact and issues	• Manual driving ⇔ human-machine interface (HMI) between vehicle and driver, beginning with transition to Lv2 • Need for high-level maintenance of white lines*, etc.	➔	• Establishment of advanced Lv4/Lv5 technologies enabling driving under adverse or suddenly changing weather conditions, on complex roads and in complex traffic conditions • Impact on laws and insurance systems*
Scenarios for issue resolution	• <u>Study of HMI (including need to create standards) [I&A]</u> • Study of road maintenance level [I, G&A]* etc.	➔	• Establishment of Lv4/Lv5 technologies including risk forecasting technologies [I&A] • Legal systems / insurance systems [I, G&A] * etc.
	• Study of road charges that promote safe road use, taking into account safety of individual roads [I, G&A], etc.		

* Repeated for common items

Note: I: industry, G: government, A: academia

Measures to resolve road traffic issues (traffic congestion) (proposed)

Category	Item		
Societal needs	Measures to reduce traffic congestion		
Scenarios for progress in technical development	Reduction of traffic congestion caused by imbalanced traffic flow due to the human factor	➔	Optimization of traffic flow through the synergy of Lv4 and Lv5 AD technologies, 5G mobile technology, the IoT, AI, big data, navigation systems, traffic management etc.
Societal impact	Reduction of traffic congestion		
Negative impact and issues	• Need for establishment of vehicle control that will not give rise to congestion • Need for establishment of systems (including road-vehicle cooperation) that can change lanes even during congestion, etc.	➔	• Need for establishment of road network management technologies that match dynamic congestion charges • Need for approaches to tax systems and road charges that reflect various costs, etc.
Scenarios for issue resolution	• Development of advanced technologies for ACC and lane change control [G&A], etc.	➔	• Study of tax systems and road charge and road use rights transaction systems, taking into account congestion status [I, G&A], etc.

Note: I: industry, G: government, A: academia

Measures to resolve road traffic issues (environmental load) (proposed)

Category	Item
Societal needs	Measures to reduce environmental load
Scenarios for progress in technical development	Reduction of environmental load along with the reduction of traffic congestion, and improved fuel efficiency due to shorter distance between driving vehicles
Societal impact	Reduction of CO2 emissions
Negative impact and issues	• Increased environmental load due to increased vehicle use • Increase in long-distance trips due to residence in the suburbs
Scenarios for issue resolution	• Dissemination of electric vehicles, motorization technologies and other new power trains [I&G] • Development of high-efficiency engines [I&A] • Study of tax systems and road charges for fossil fuel vehicles and electric vehicles [I, G&A] • Coordination with urban policy [I, G&A] • Dissemination of ride sharing systems [I, G&A], etc.

Note: I: industry, G: government, A: academia

Measures to resolve issues relating to public transport systems (proposed)

Category	Item
Societal needs	Ensuring mobility for vulnerable transport users (senior citizens, physically disabled, young people)
Scenarios for progress in technical development	Lv2 personal vehicles (PVs) with advanced driving safety support, provided by means of restriction-relaxed licenses that enable users from young people to senior citizens to drive
Societal impact	Ensuring mobility (increased opportunities and expanded environment for driving oneself), health improvement by driving oneself
Negative impact and issues	• Need to establish requirements for restriction-relaxed licenses (capacity assessment) • Need for policies to disseminate Lv2 vehicles, etc.
Scenarios for issue resolution	• Establishment of requirements for restriction-relaxed licenses (capacity assessment) and establishment of new systems for licensing and training [G] • Obligation of people who do not meet restriction-relaxed license requirements to surrender license [G] • Study of measures to disseminate Lv2 vehicles [I&G], etc.

* Repeated for common items

Note: I: industry, G: government, A: academia

Measures to resolve issues relating to public transport systems (proposed)

Category	Item		
Societal needs	Ensuring mobility for vulnerable transport users (senior citizens, physically disabled, young people), Measures to alleviate the shortage of public transport drivers and reduce operating costs, and ways to improve profitability of public transport operators		
Scenarios for progress in technical development	• Regular route buses and joint ridership bus service through Lv2 restriction-relaxed licenses • Low-speed, small group transport service (Lv4, limited routes, dedicated area Lv4)	➔	• Lv4/Lv5 regular route buses and joint ridership service • Lv4/Lv5 individual use of car sharing type self-driving vehicles, use of on-demand type and patrol type Lv4/Lv5 services for small group joint ridership
Societal impact	Ensuring mobility (maintenance of public transport etc.), regional stimulation, emergence of Lv4 car sharing service operators, emergence of mobility providers and other platform providers, alleviation of driver shortage and the crew specialized in conductor tasks		
Negative impact and issues	• <u>Need to ensure societal acceptance for Lv4 vehicles*</u> • Need to construct the infrastructure required for Lv4 vehicles, clarify maintenance standards and devise measures for early deterioration* • Need to establish social systems relating to Lv4 vehicles, such as legal and insurance systems* • Need to organize requirements for establishment of business models, etc.	➔	Return to compact cities, concern for increased costs throughout society as a whole, etc.
Scenarios for issue resolution	• Promotion of public understanding and societal acceptance of Lv4 vehicles [I, G, society &A] * • Study of infrastructure requirements for Lv4 vehicles [I, G&A]* • Study of legal systems and insurance systems for Lv4 vehicles [I, G&A]* • Fee structure for business establishment and assessment of corporate structure from the standpoint of social welfare and social efficiency [I&A], etc.	➔	• Reassessment of urban transport strategies to add AD technologies, including road charges and tax systems [G], etc.

* Repeated for common items

Note: I: industry, G: government, A: academia

Measures to resolve issues relating to public transport systems (proposed)

Category	Item		
Societal needs	Improving the level of service (LOS) in public transport		
Scenarios for progress in technical development	Achievement of Advanced Road Transportation (ART) concept through the use of Lv2 buses (precise vehicle stop control, smooth acceleration and deceleration, bus priority control, achievement of Mobility-as-a-Service using AD buses through dedicated/ priority lane construction, ecosystem construction)	➔	Achievement and evolution of high-speed, “barrier-free” ART concept using Lv4/Lv5 buses
Societal impact	Increasing the convenience of public transport and freeing up of urban space through use restrictions on privately owned vehicles in the city center		
Negative impact and issues	• Need to determine whether or not public financing assistance measures are needed, etc.	➔	• Need to ensure smooth transport in high-density mixed traffic environments • Need for optimization of rail and road, redesign of urban spaces etc.
Scenarios for issue resolution	• Study of public financing assistance [I, G&A], etc.	➔	• Development of technologies to ensure smooth transport, etc. [I&A] • Establishment of new design guidelines, etc. for rail, road and urban planning [I, G&A], etc.

Note: I: industry, G: government, A: academia

Measures to resolve issues relating to logistics systems (proposed)

Category	Item		
Societal needs	Measures to resolve the driver shortage and reduce logistics costs		
Scenarios for progress in technical development	Unmanned vehicle operation (Lv4) with Lv2 restriction-relaxed licenses in limited environments (electronically coupled vehicles operating in limited areas or on dedicated routes, etc. including expressways)	➔	Wide-area unmanned operation (Lv4/Lv5)
Societal impact	Improvement of driver shortage, reduction of logistics costs, high-efficiency logistics, reorganization of business scheme		
Negative impact and issues	• Need for Establishment of environment (requirements for restriction-relaxed licenses, legal status of electronically coupled vehicles, securing of location for forming electronic coupling, status in terms of labor management, optimization of location planning for logistics centers, establishment of system for mixed cargo and passenger transport etc.) • Need to carefully assess conditions for establishment of business models • Need to increase acceptance on the part of drivers of surrounding vehicles, etc.	➔	• Need to carefully assess new costs (maintenance, operation, tax and fee systems) • Need for advanced management of people and goods (including study of redeployment of logistics facilities) • Need to deal with the creation of monopolies and oligopolies due to increased size of operators as a result of reduced costs including personnel costs, etc.
Scenarios for issue resolution	• Environment establishment above mentioned [I, G&A] • Study of establishment of business models [I, G&A] • Study of HMI with surrounding vehicles (including need to establish standards) [I&A], etc.	➔	• Study of costs and tax and fee systems [I&A] • Study of advanced management for people and goods [I&A] • Measures for creation of monopolies and oligopolies [I, G&A], etc.

Note: I: industry, G: government, A: academia

Measures for common items (proposed)

Category	Item	
Item	Legal systems and insurance systems	Infrastructure
Societal impact	• Significant decrease in automobile insurance premiums • Sale of new cyber-security, etc. insurance • Use of alternative dispute resolution (ADR) for AD vehicle accidents	–
Negative impact and issues	• Need for clarification of criminal and civil liability for accidents involving Lv2 or higher vehicles and legal examination of relevant compensation insurance • Need for establishment of mechanism for handling event data recorders (EDR) in the event of an accident • Need for establishment of approach to AD vehicle ADR in accordance with the development of substantive laws and regulations as a precondition, etc.	• Need for clarification of necessary infrastructure and maintenance standards (need for concentrated and selective investment due to increasingly high costs) • Need for high-level maintenance standards for white lines, etc. (relationship to road administration defects, product liability etc. and provision of balance) • Possibility of early deterioration due to rutting caused by Lv4 vehicles driving on the same track, etc.
Scenarios for issue resolution	• Development of automobile insurance that takes into account telematics and safety of roads being traveled • Clarification of the applicability of automobile liability insurance to accidents occurring during operation in which the driver was not involved • “Legal examination of criminal and civil liability” and “Establishment of mechanism for investigating accidents (including the use of EDR)” for accidents occurring during operation in which the driver was not involved (Lv2 or above) • Establishment of study organization for investigation into the causes of accident, etc.	• Study of establishment of infrastructure requirements for Lv4 vehicles [I, G&A] • Study of road maintenance standards [I, G&A] • Study relating to securing financial resources for maintenance through tax systems and road charges based on use [I, G&A], etc.

Note: I: industry, G: government, A: academia

Measures for common items (proposed)

Category	Item	
Item	Education, ethics and social customs, and social acceptance	Introduction of policies to promote dissemination
Societal impact	• Improved visibility of AD vehicles • Increased awareness of the importance of traffic safety	• Dissemination of AD vehicles
Negative impact and issues	• Need to promote societal acceptance with regard to the risks involved in introducing AD vehicles (system cannot ensure zero accidents, system involves social dilemma and other ethical issues) • Establishment of guidelines for explanations to AD vehicle purchasers and users (equivalent to informed consent in medicine) • Need for establishment of rules to replace eye contact, etc. and new traffic education • Need for establishment of social support systems for senior citizens, etc. with regard to the change in the transport environment • Need for systems and new traffic rules that will be accepted by society, etc.	• Danger that AD vehicles will not be disseminated without policy support
Scenarios for issue resolution	• Promotion of public understanding and societal acceptance (of Lv4 vehicles) [I, G, society &A] • Establishment of new driving instruction systems and establishment of new traffic education systems when renewing licenses [I&A] • Establishment of new traffic rules [I, G&A] • Research into interaction of pedestrians, bikes and AD vehicles [I&A] • Development of new traffic education to replace conventional traffic safety education for schools (designed for children) and local communities (designed for senior citizens, etc.) [G&A], etc.	• Establishment of economic incentives for installing AD systems that take into account their external nature [G] • Expansion of vehicle types subject to mandatory system installation and expansion of types of devices (at present, installation of collision mitigation braking system (CMB) and lane departure warning systems (LDWS) are mandatory for heavy vehicles) [G] • Promotion of trade-ins to replace existing vehicles with new vehicles (establishment of scrap incentives for old manual vehicles, etc.) [G] • Formation of a critical mass for ownership of V2V and V2P system-equipped vehicles [I&G] etc.

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Measures for common items (proposed)

Category	Item	
Item	Information and communications technologies	Response to a large-scale natural disaster or terrorist attack
Societal impact	• Expansion of activities of communications equipment manufacturers and communications companies	–
Negative impact and issues	• Increased load on information and communications networks and reduced communication speed • Need to make installation of communications equipment obligatory (need to give advance notice calculating backward from automobile service life, for example 10 years beforehand) • Need to standardize communications protocols (V2V and V2I) • Need to study improvement of dedicated communications protocols for AD • Expansion of responsibilities with respect to communications equipment manufacturers and communications companies etc.	• Unable to share information when traffic control system crashes, exacerbating congestion • Need to establish emergency evacuation rules (destination selection, dynamic generation of evacuation routes) • Need for emergency shutdown judgment in the event of infrastructure collapse resulting from a major earthquake etc.
Scenarios for issue resolution	• Increased communication speed and development of technologies for capacity expansion [I&A] • Strategic compliance with international standards [I&A] Development of broadband communications including “back end” side and low delay technologies [I, G&A] • Active participation in 5G and other communications standardization [I, G&A] • Legal and insurance measures for communications-related responsibility [I, G&A] • Development of advanced software updating technologies (including security) and clarification of legal response [I, G&A] etc.	• Formulation of scenarios for use in the event of a large-scale natural disaster or terrorist attack [G] • Development of optimal evacuation destinations and routes in accordance with scenarios, and establishment of methods for information provision and guidance [I, G&A] • Establishment of damage prediction systems for use in the event of a disaster [G&A] etc.

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[Common items]

Cybersecurity measures (proposed)

Category	Item		
Item	Cybersecurity (vehicle systems)	Cybersecurity (social systems)	Cybersecurity (services)
Societal impact	–	–	–
Negative impact and issues	• Obligatory installation of event recorder in vehicle • Development of legal systems for log registration that permit third party authorization • Safe storage for log data that permits third party authorization • Establishment of third party authorization entity • Creation of framework for sharing of vulnerable information and creation of common language • Obligatory wiping of privacy data when equipment is discarded • Vehicle authorization and type approval • Obligatory remote monitoring from outside vehicle, and Large-scale real-time remote monitoring and automation • Establishment of technologies for OTA* software delivery • Establishment of emergency call system • Authorization and certification of third party add-on products, etc.	• Establishment of system for punishment of attackers • Establishment of security research programs on actual roads • Prevention of mischief and monitoring of on-line conversations • Elimination and regulation of illegal tools • Sharing of (ordinary user) vulnerable data • Sharing of information with security providers • System of tax incentives for vehicles with enhanced security • Auditing of service providers • Systems for tax and insurance incentives, etc.	[Platooning and electronically coupled driving] • Increased safety for electronic coupling technologies • Jamming of electronic connection • Theft using electronic coupling • Illicit use of electronic coupling [Public transport systems] • Service for secure data provision to service providers • Prevention of illicit use by service users • Prevention of illegality by means of online payment • Secure shipment scheduling, etc.
Scenarios for issue resolution	• Legal administration of drive recorders [I, G&A] • Prevention of falsification or non-authorization by authorization entity [I&A] • Standardization of secure login inside vehicle [I&A] • Real-time remote vehicle monitoring [I&A] • Authorization of AD technologies by public institutions [I, G&A] • Large-scale real-time remote monitoring [I, G&A] • Advanced certification management and automation [I&A] • Provision of privacy data to certification management entity [I, G&A] etc.	• Establishment of system for punishment of entities that share vulnerable data [I, G&A] • Establishment of system for security research on driven roads [I&A] • Strengthening, by industry groups, of institutions charged with monitoring attacks [I&A] • System for tax incentives for enhanced security [I&A] • Prevention of illicit behavior by service providers [I, G&A] • Cost, tax systems and fee systems [I, G&A] etc.	• Enhanced security for electronic coupling technologies [I, G&A] • Increased safety for electronic coupling [I&A] • Establishment of technologies to prevent illicit use [I&A] • Establishment of technologies to prevent theft [I&A] • Secure data provision to certification management entities [I, G&A] • Establishment of technologies to prevent illicit use [I, G&A] • Advanced certification management [I&A] etc.

* OTA: Over-The-Air

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