Study on analysis of social and industrial aspects involved in the effort to develop more advanced automated driving systems and ensure their widespread use

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- Background to study

- Establishment of study team

- Evolution of automated driving systems

- Social and industrial impact on automated driving systems

- Proposed future study

- Proposals for the establishment of a framework for industry, academic and government collaboration

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Background to study

- The following will be needed in order **to develop more advanced automated driving systems** and **ensure their widespread use**:
    - **Clarification of the risks** that result from the domestic and international impact and change on society and industry
    - **Formulation of measures** to mitigate impact and risks **and scenarios** from a long-term perspective
    - **Greater understanding** of automated driving systems on the part of the general public

- **Clarification of the impact on society and industry** and **basic study** for the purpose of formulating medium- and long-term scenarios

- **Study on an open study organization** with industry, academic and government collaboration

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Establishment of Study Team

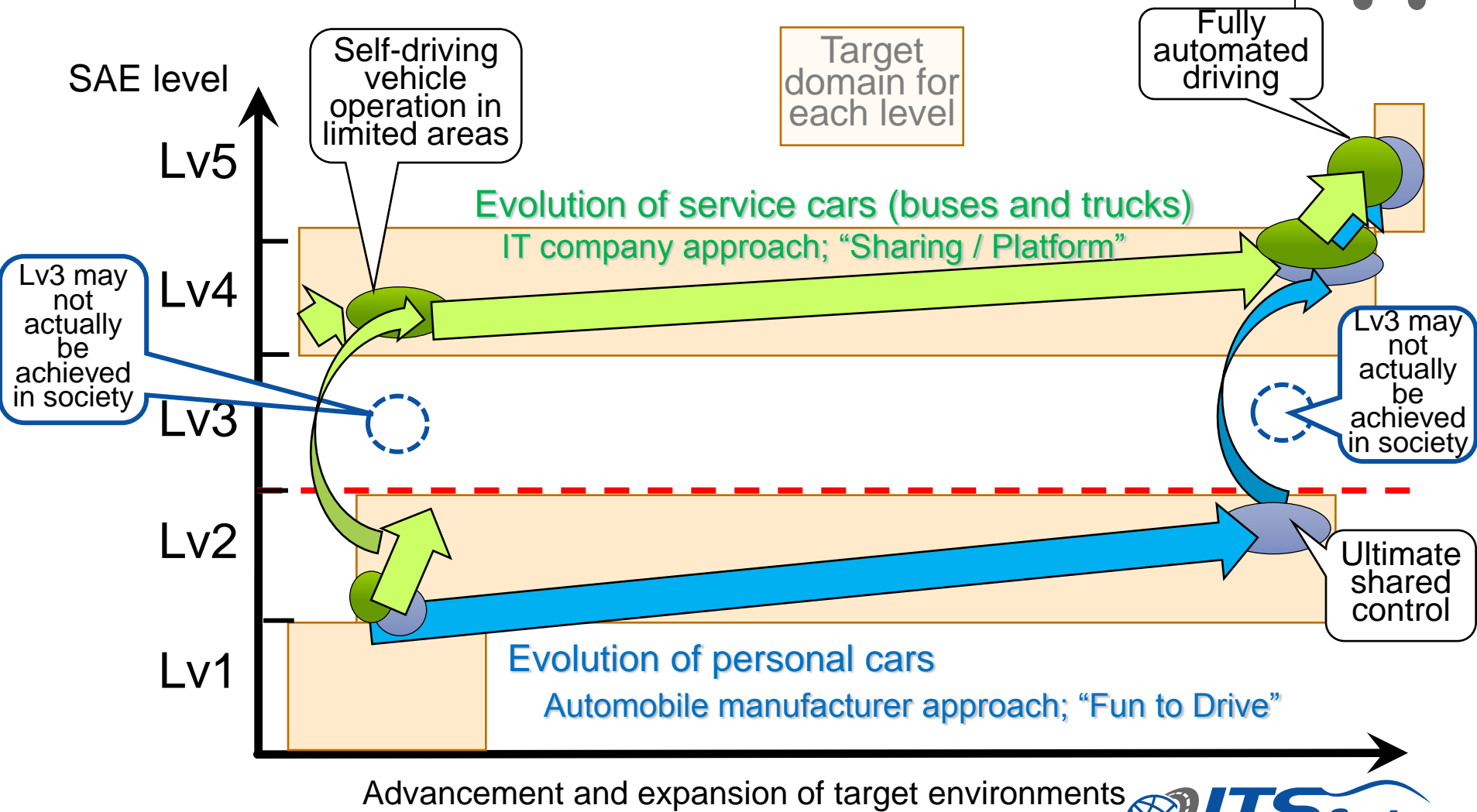| Name	Affiliation	Speciality
Masato Itohisa	Hosei University	**Technology management**
Takeyoshi Imai	Hosei University Graduate School of Law	**Criminal law**
Keisuke Uehara	Keio University	**Information and communications**
○**Takashi Oguchi**	The University of Tokyo	**Traffic management and control**
Shusuke Kakiuchi	The University of Tokyo	**Civil procedure law**
Yuto Kitamura	The University of Tokyo	**Education**
Yasuhiro Shiomi	Ritsumeikan University	**Traffic engineering**
Naoki Suganuma	Kanazawa University	**Robotics engineering**
Akihiro Nakamura	Yokohama City University	**Public economics**
Akinori Morimoto	Waseda University	**Urban planning**
Pongsathorn Raksincharoensak	Tokyo University of Agriculture and Technology	**Mechanical dynamics control**
Goro Yamazaki	Osaka University	**Cultural anthropology**

○: Chairman

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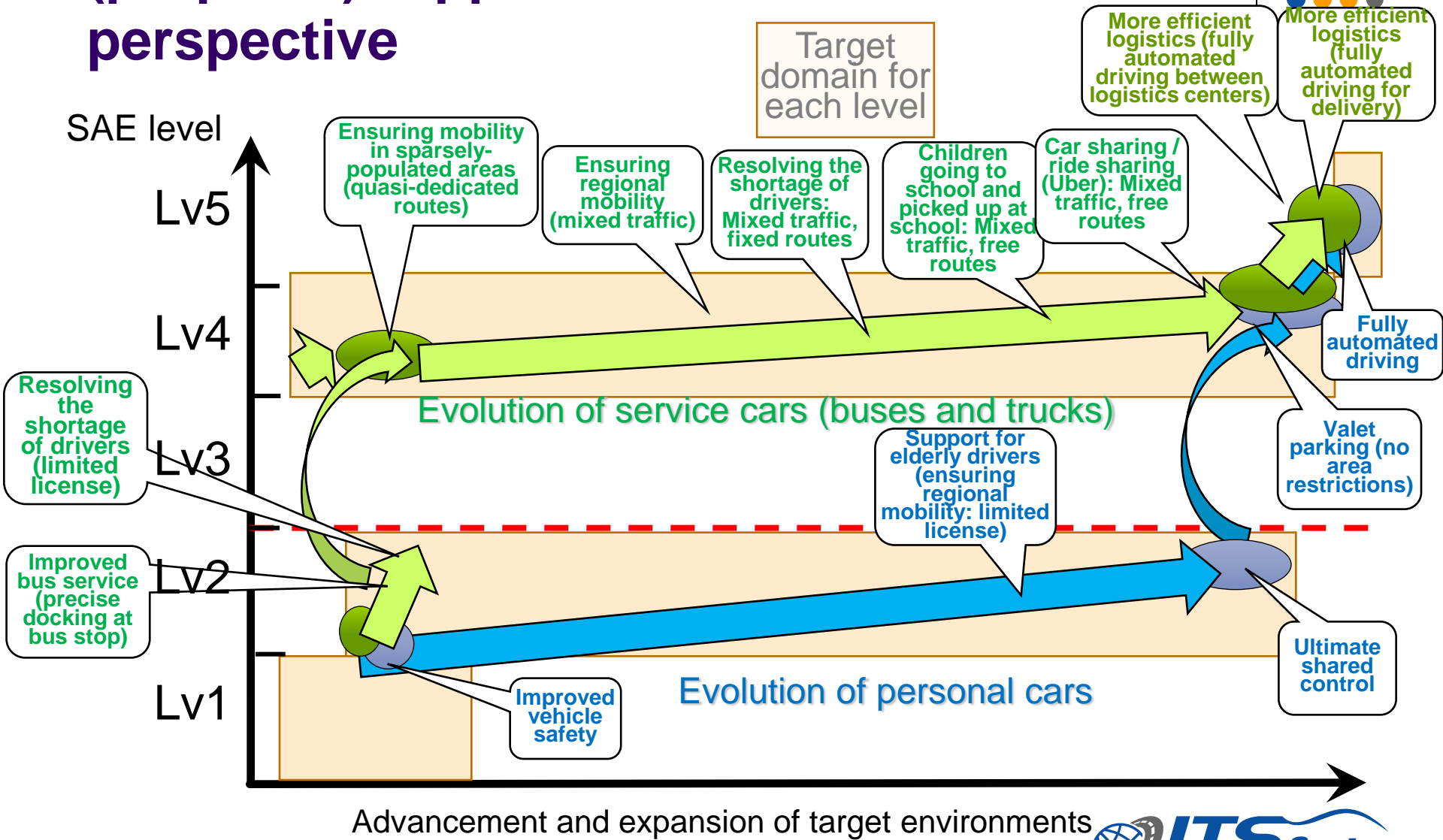- Conclusion

Evolution of automated driving systems

- **Automated driving systems will evolve at two levels** (Lv2 and Lv4)**.**

  - In practice, **Lv3 passengers will be assigned the same responsibilities as drivers** under current law.

  - At Lv3, **passengers must become drivers if needed**. Safety cannot be ensured by having the automated driving system replace human beings even in situations that cannot be handled by the most advanced technology.

  - Most of social needs are classified as Lv2 and Lv4.

  - **Lv3 might exist if the level (skill) of the driver were high**, but in general drivers will not like Lv3 vehicles.

- → **Discussions of the impact** of automated driving systems on society and industry **should focus primarily on Lv2 and Lv4.**
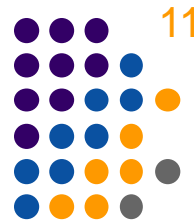
Evolution of automated driving systems (proposal)

SAE level

Lv5

Lv4

Lv3

Lv2

Lv1

Self-driving vehicle operation in limited areas

Target domain for each level

Fully automated driving

Evolution of service cars (buses and trucks)
IT company approach; "Sharing / Platform"

Lv3 may not actually be achieved in society

Lv3 may not actually be achieved in society

Ultimate shared control

Evolution of personal cars
Automobile manufacturer approach; "Fun to Drive"

Advancement and expansion of target environments

Evolution of automated driving systems (proposal): Approach from a social needs perspective

Evolution of automated driving systems (proposed roadmap)

SAE level

Lv5

Lv4

Lv3

Lv2

Lv1

[2020] Unmanned vehicle operation in limited areas

[2020s] Expansion of target areas / environment for self-driving vehicle operation (from automated-vehicle-only environments to mixed environments)

[2030 and thereafter] Fully automated driving between logistics centers

[2030 and thereafter] Fully automated driving for logistics deliveries

[2030s] Fully automated driving

[2030s] Valet parking

Evolution of service cars (buses and trucks)

[2020] Advanced Rapid Transit (precise docking at bus stop in limited areas)

[2020s] Buses in urban areas

[2020] Platooning on expressways (lead vehicle)

[2020s] Ultimate shared control

[2020s] Advanced driving support system for elderly drivers

Evolution of personal cars

[2016] Nissan Serena, Tesla...

Advancement and expansion of target environments

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Classification of anticipated impacts

● **Impact classification based on a two-way evolution**

	Lv2 advancement	Lv4	Common items
"People flow" personal vehicles	・Reduced traffic accidents (elderly drivers) (+) ・Support for vulnerable road users (elderly drivers, etc.) (+) ・Impact on (the easing of) the licensing system (+) etc.	・	・Enjoyment of mobility (+), etc.
"People flow" service vehicles (buses)	・Resolution of driver shortage (limited license) (+) ・Improved bus service (precise location stop control) (+)	・Support for vulnerable road users (elderly drivers, etc.) (+) ・Regional revitalization, regional stimulation, measures to mitigate depopulation (+) ・Impact on urban and rural systems, national land planning and urban design (+, -) ・Impact on the concept of public and cost burden (+, -) ・Impact on social benefit and imposition of additional obligation (+, -)	・Reduced transit costs (+) ・Resolution of driver shortage (+) ・Enjoyment of mobility (+), etc.

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Classification of anticipated impacts

● **Impact classification based on a two-way evolution**

	Lv2 advancement	Lv4	Common items
Logistics service vehicles (trucks)	・Resolution of driver shortage (limited license) (+) ・Reduction of the manual driving load on drivers (+) etc.	・Reduction of logistics and distribution costs (+) ・Resolution of driver shortage (limited license) (+) etc.	・Reduction of logistics and distribution costs (+) ・Impact on transit of other vehicles (-) ・Impact of platooning formation and disbanding (construction of new road infrastructure (+,-) etc.

Classification of anticipated impacts

● **Impact classification based on a two-way evolution**

	Lv2 advancement	Lv4	Common items
Common items		・Impact on social acceptance and ethical philosophy (+,-) ・Impact on legal system (+,-) ・New insurance needs (+) ・Impact on infrastructure construction and maintenance level (+,-) ・Impact on new infrastructure construction (highly accurate maps) (+,-) ・Additional driving vehicle-kilometers, congestion and environmental load (-) ・Impact on taxes, charges, beneficiary burden etc. (+,-) ・Impact on medical and nursing care, health and welfare (+) ・Change in activities of people during transit (+) ・Impact on traffic education (+,-) ・Impact on new licensing systems (-) ・Impact on automotive industry and related industries (+,-) etc.	・Cyber attack and terrorism risk (-) ・Reduction of environmental load (+,-) etc.

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Impact on the automotive industry

- At the initial stages of dissemination, **automated vehicles will play a major role in public transport and sharing services**.
  - **High purchase cost** and need to ensure **high technical capabilities** for maintenance and inspection
  - **Dissemination of automated vehicles** will coincide with **the expansion of the market for sharing services**
- Progress of **sharing services** ➔ shift from "Fun to Drive" to "**Fun to Move**" ➔ <u>**The rulers of the service platforms** that link customers with mobility services **will be the rulers of the new ecosystem**.</u>
  - Example: Google provides the OS (Android) free of charge to create end manufacturer partners, accelerating the spread of the service platform (Google Play)
- **As the products become more complex**, **the industrial configuration evolves** from a closed integrated type (vertically integrated) **to an open modular type (horizontally distributed)**.
  - Open modular worlds make it easy for Winner-Take-All default players to be born in each module.
    - Example: In the IT industry, Intel, Microsoft, Google, Facebook etc.
  - Companies that can become default player candidates are present in automated driving systems as well.

Considerations and items for study regarding anticipated impact

● **Preconditions for impact**

	Lv2 advancement	Lv4	Common items
"People flow" personal vehicles	・Determination of specific Lv2 technologies needed to deal with traffic accidents involving elderly drivers ・Determination of specific Lv2 technologies needed to support limited mobility elderly drivers		・Organization of conditions needed to make mobility enjoyable
"People flow" service vehicles (buses)	・Organization of conditions that will lead to improved bus service etc.	・Determination of specific Lv4 technologies needed to support vulnerable road users and analysis of cost structure ・Determination of specific Lv4 technologies needed for regional revitalization, regional stimulation and measures to mitigate depopulation, and analysis of cost structure (including conditions for infrastructure construction) ・Determination of specific impact on urban and rural systems, national land planning and urban design ・Organization of impact on the concept of public and cost burden ・Careful analysis of social benefit and analysis of costs arising from imposition of additional obligation	・Analysis of transit cost structure ・Organization of conditions needed to make mobility enjoyable

Considerations and items for study regarding anticipated impact

● **Preconditions for impact**

Logistics service vehicles (trucks)	Lv2 advancement	Lv4	Common items
	・Organization of conditions that will lead to reduced driver burden	・Analysis of cost structure for logistics and distribution overall ・Conditions that will lead to easing of driver shortage problem (ranking under Labor Standards Law) etc.	・Analysis of cost structure for logistics overall ・Organization of impact on other vehicles and conditions needed to minimize adverse impact ・Organization of impact of platooning formation and disbanding (construction of new infrastructure etc.) and conditions needed to minimize adverse impact, etc.

Considerations and items for study regarding anticipated impact

● **Preconditions for impact**

Common items	Lv2 advancement	Lv4	Common items
	・Organization of (the easing of) the licensing system	・Analysis of conditions for social acceptance and relation to ethical philosophy (including passenger and operator acceptance) ・Clarification of legal responsibility and establishment of safety net ・Construction of necessary infrastructure and clarification of maintenance standard ・Construction standard for necessary new infrastructure (highly accurate maps etc.) and cost analysis for upgrades, etc. ・Analysis of impact of additional driving vehicle-kilometers, congestion and environmental load ・Analysis of impact on taxes, charges, beneficiary burden etc. ・Analysis of impact on medical and nursing care, health and welfare ・Analysis of change in activities of people during transit ・Analysis of impact on traffic education ・Study of need for new licensing categories ・Impact on automotive industry and related industries etc.	・Analysis of effect of cyber attack and terrorism risk ・Analysis of effect on reduction of environmental load etc.

Verification and evaluation of impact on society and industry

- Proposal for study of (policy) key performance indicators (KPI) and follow-up items for evolution /practical application of automated driving systems

  - **KPI to show the progress** in the evolution/practical application of automated driving systems

    - **Status of technology dissemination** (Lv2 and Lv4) (Example: <u>number of vehicles sold</u>, etc.)

    - **Status of technology advancement and expansion of target environments** (Example: <u>number of revisions and additions to relevant laws and standards</u> with the aim of disseminating automated driving)

    - **Status of practical application of services** (platooning, the "last mile" etc.) (Example: <u>Number of locations where practical application of services has occurred</u>)

  - **Follow-up items to ensure** that evolution/practical application is significant

    - **Increase in social acceptance** (Example: <u>Number of field testing and practical application locations</u>, etc.)

    - **Increased use of sharing services** (Example: <u>Number of sharing service users, use vehicles</u> etc.)

    - **Achievement or creation of new services** (Example: <u>Number of companies engaged in new business</u>, etc.)

    - **State of change in automobile manufacturing** (Example: <u>shift to a horizontally distributed model</u>, etc.)

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Proposed future study

- Proposed study content for the next 2 - 3 years
  - **<u>Social acceptance</u>**
    - Promotion of social acceptance of the risks
    - Relationship with other drivers, pedestrians, and cyclists (HMI in the broad sense)
    - Customer acceptance
    - Building up achievements to publicize the system, and strategy for advertisement and education to the general public
  - <u>Study on coordination with **introduction of public funds** and **market principles** to introduce and operate automated driving systems</u>
    - Redefinition of public transport
  - **<u>Relationship to urban design</u>**
    - Change in residential locations due to change in the cost structure of mobility services
  - **<u>Creation of markets</u>** and **<u>need for marketing</u>**
    - Verification of business model (study of business ecosystem)
    - Matching the needs of users and social system and the seeds of technologies
  - **<u>International cooperation</u>** <u>to achieve international mutual understanding</u>

Proposed future study

- Proposed content to be executed over the medium- to long-term
    - Study of the need for **new license categories** (license limited to Lv2)
    - Clarification of **legal responsibility** and establishment of **safety net**
    - Creation of **more acceptable (new) traffic rules**
    - Clarification of the **infrastructure and maintenance standards** that will be needed
    - **Analysis of the effect** on driving vehicle-kilometers, congestion and environmental load (including analysis of changes to **traffic management frameworks**)
    - Study of **flameworks, organizations and directions of international cooperation** such as establishment of international standardization and specification
    - Study of **low-cost and bare-bones automated driving systems in developing countries** (development of new markets)
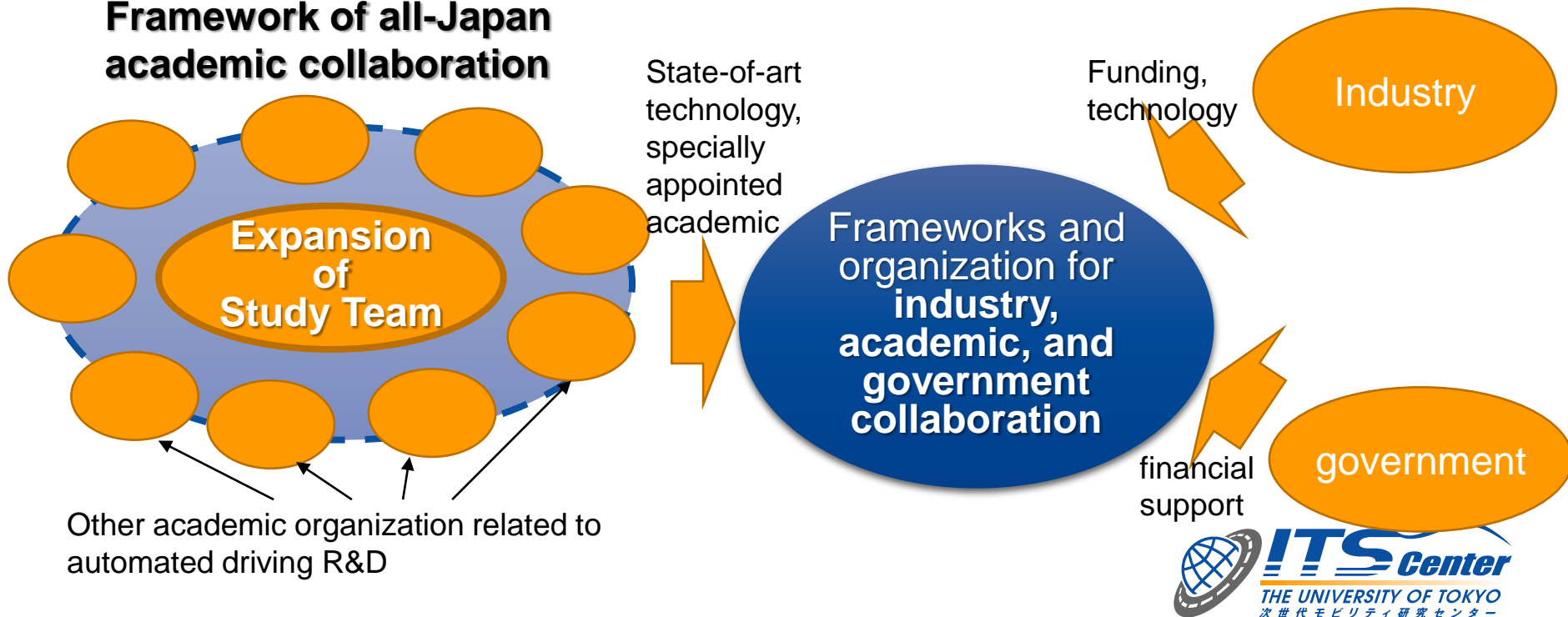
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Proposals for the establishment of a framework for industry, academic and government collaboration

- **Continuation and expansion of the study team**
- Study of **framework of all-Japan academic collaboration**
- Creation of flameworks and organization for **industry, academic and government collaboration**

Framework of all-Japan academic collaboration

Expansion of Study Team

State-of-art technology, specially appointed academic

Frameworks and organization for **industry, academic, and government collaboration**

Funding, technology

Industry

financial support

government

Other academic organization related to automated driving R&D

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Conclusion

- **Study team** centering on university specialists was established

- We proposed that **automated driving systems will evolve at two levels** (Lv2 and Lv4) and discussions of the impact on society and industry should focus primarily on Lv2 and Lv4

- **Anticipated social impact** was classified based on a two-way evolution and **industrial impact** was discussed

- **Future study** content for the next 2 - 3 years and mid- and long term was proposed

- The **establishment of a framework** for industry, academic and government collaboration was proposed

Thank you for your kind attention