6 Promoting International Cooperation

Overview

Manabu Umeda (The University of Tokyo, Collaborative Research Coordinator for SIP-adus)

1 International cooperation activities

Automated driving technologies has been improved dramatically with the participation of various industries, including companies in the information services and startups in addition to current automobile manufacturers. Automobile manufacturers are actively producing and selling cars both in Japan and other global markets. Various activities such as automotive technologies development, infrastructure, standardization, legislative issues, and Field Operational Tests (FOTs) are being addressed throughout the world.

As the automotive industry plays a crucial role in Japan, in order to maintain the international competitiveness of automobile industries and its related businesses, it is necessary to take the initiative in standardization and regulatory activities, and to work toward international harmonization. Consequently, the strengthening of international cooperation defined as one of the four major activity pillars of the second phase of SIP-adus, and information on its research outcomes were actively communicated to other countries. Furthermore, investigative research and other activities necessary to strengthen international cooperation were addressed for the purpose of providing open research and development that would induce active discussions, as well as creating opportunities for social implementations.

Along with Japanese-German cooperation launched in the first phase of SIP-adus, Japanese -EU cooperation was addressed through exchange of views regularly in the second phase of SIP-adus. We also sought the opportunities to cooperate with the U.S. by continuous information exchange through international conferences. To promote this international cooperation activities with regard to automated driving, we broadly enhanced the cooperation and sharing information among experts of universities and research institutes in Japan across the humanities and sciences, and supported joint research activities with research institutes in the U.S. and Europe. In addition, we addressed to launch a new association that would enable these international cooperation scheme to continue even after the second phase of SIP-adus.

2 Setting focus themes and developing a framework for international cooperation

2.1. Setting focus themes for international cooperation

At SIP-adus, the seven focus themes described in sections 2.1.1 to 2.1.7 were identified by enhancing the international cooperation activities addressed in the first phase of SIP, and theme leaders responsible for promoting international cooperation activities in each research fields were assigned.

2.1.1. Dynamic Map

Digital map databases with a layered structure built on graph network representation of roads will be expanded widely including highly detailed description of the road structure and its surrounding environment. The databases will be dynamically linked to real time information from an integrated sensor systems onboard the vehicles and semi-real time information from V2X communications. The development of such databases is only possible through collaboration across industry sectors and public agencies. [See Section 6 3) for more details]

2.1.2. Human Factors

The shift between levels of automation will depend on the driving environment and the driver's condition along the trip. It is important to design automated vehicle systems to effectively communicate with the driver, so that the situational awareness of the driver is maintained and the transition between the levels of automation is properly performed. [See Section 6 4) for more details]

2.1.3. Safety Assurance

How safety is assured is an extremely critical aspect of implementing automated driving technologies into the society. Reliable and efficient test methods will be required in order to assure the safety for automated driving. Ensuring the safety of complex electronic systems and software requires virtual testing environments in cyberspace. Various evaluation methods for validation, modeling, and simulation are under development. [See Section 6 5) for more details]

2.1.4. Connected Vehicles

High levels of automation require a larger range of observation of the driving environment. The deployment of connected vehicle technology will be advantageous to automated driving systems. Proximity will be sensed by integrated sensors onboard the vehicle, and physically blind vehicles will be notified through vehicle to vehicle (V2V) communication. Furthermore, providing traffic signal and other infrastructure information to automated vehicles through vehicle to infrastructure (V2I) communication facilitates the realization of smoother and safer automated driving. [See Section 6 6) for more details]

2.1.5. Cybersecurity

A connected car is a car that has become capable of providing various services, which enhance its convenience and safety, through DSRC and cellular communication. However, a connected car is also at risk from cyberattacks, and new types of cyberattacks are regularly reported at international conferences such as BlackHat in the field of vehicle cyber security. Cybersecurity measures will have to continue to be reinforced to keep systems secure in the future. Therefore, it is essential to share information and promote collaboration among industry and government across the conventional boundaries between sectors. [See Section 6 7) for more details]

2.1.6. Impact Assessment

Demonstrating the economic and social benefits provided by automated driving technologies and understanding its latent risks will be essential for automated driving technologies to be widely accepted in public. Considering the level of automated driving technologies and its dissemination status, having an open discussion for its effects and latent risks by automated driving technologies is necessary, through guiding the analysis and quantitative effects of the impact of automated driving with respect to reducing traffic accidents, decreasing CO2 emissions, and mitigating traffic congestion, defining its long-term vision in Japan. [See Section 6 8) for more details]

2.1.7. Service and Business Implementations

In the central districts of large cities with high-density travel demand, a pedestrian-centered multimodal transportation network is anticipated to offer efficient and sustainable mobility. Innovative transportation systems featuring automated driving technologies and on-demand operation will reduce travel time while making trips comfortable for passengers, and enhance efficiency for operators. In contrast, small size vehicles with enhanced driver assistance for personal use are also anticipated to provide aged or vulnerable road users and to encourage them to actively engage in social activities.

Various activities regarding new mobility services and mobility innovation by utilizing automated driving technologies, are being carried out worldwide. [See Section 6 9) for more details]

2.2. Developing a framework for international cooperation

In the second phase of SIP-adus, along with experts on all the focus themes mentioned above, an international collaborative research coordinator was assigned under the steering committee of SIP-adus to act as an overall window for international cooperation activities. In addition, with the goal of developing a long-term international cooperation framework with overseas research institutes beyond the second phase of SIP-adus, meetings named "Alliance for promoting mobility innovation" were held, and the framework for international cooperation shown in Fig.1 was established. This "Alliance for promoting mobility innovation" provides opportunities for the exchange of information and views among the research teams, universities' research centers and research institutes in Japan, and provides opportunities to promote research and development activities in academic fields.

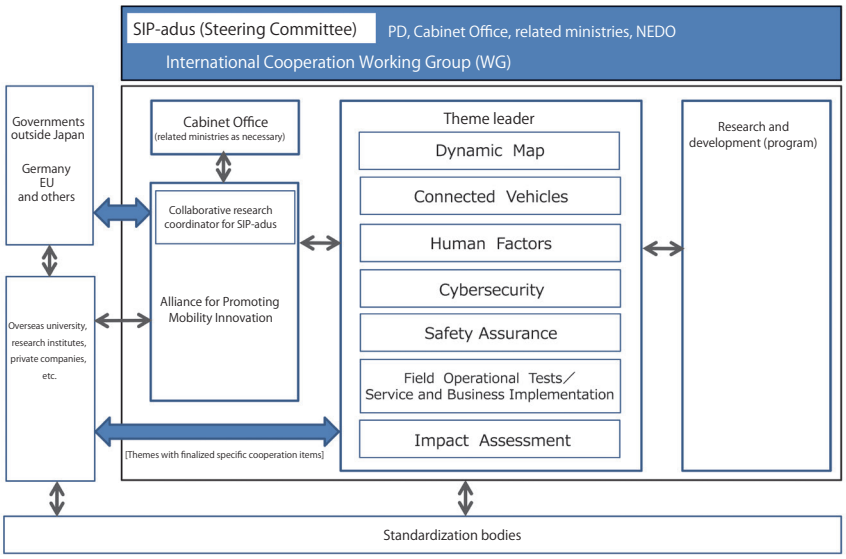

Fig.1: The SIP-adus framework for international cooperation activities

3 Overview of activities to promote international cooperation

3.1. Building networking of experts and Collecting information for international research trends through international conferences

The international cooperation theme leaders for SIP-adus actively participated in international conferences such as ITS World Congress, Transportation Research Board (TRB) in U.S., or EU-CAD (Connected Automated Driving) in Europe, to engage and consolidate their expert network through information exchange with overseas experts, and collected the latest trend research information. In addition, a collaborative research coordinator for SIP-adus built connections with governmental organizations such as the U.S. Department of Transportation (USDOT) and the Directorate-General for Research and Innovation (DG-RTD) of the European Commission, and these connections contributed to establish a new research network by introducing experts or research project coordinators through those governmental organizations based on the requests from each experts, along with acquiring the latest project information regarding automated driving research in U.S. and Europe.

3.2. Japanese-German and Japanese-EU Cooperation Activities

Japanese-German cooperation activities have been carried out between the Japanese Cabinet Office and the German Federal Ministry of Education and Research, based on the Joint statement to enable scientific exchange in automated driving and to identify areas for potential research and development activities on Science, Technology, and Innovation. As a result, it was agreed to start joint research activities in the fields of "Human Factors" and "Impact Assessment" in 2019, and a further joint research activities in the fields of "Safety Assurance" and "Cybersecurity" were agreed in 2020, thus Japanese-German joint research activities were carried out in total 4 research topics. Japanese-German cooperation has produced various outcomes in each research topic, including contributions to international standardization activities, joint book publications of research results, and exchanges of young researchers through joint workshops, that demonstrated the importance of Japanese-German cooperation, because both countries have the automobile industries as a core industry. A joint brochure to summarize the research cooperation outcomes has been published.

With respect to Japanese–EU cooperation activities, an agreement to consider cooperation opportunities between the existing projects, the Horizon 2020 in EU Framework Programme for Research and Innovation and the SIP-adus research project, was reached with the Directorate-General for Research and Innovation (DG-RTD) of the European Commission, and potential cooperation opportunities were studied. As a result, 3 cooperation activities with the project under the Horizon 2020 framework were carried out by holding joint workshops, etc. In Europe, a new research and innovation framework, "Horizon Europe" was launched in 2021, and it is expected to initiate further cooperation activities with new research projects regarding connected automated driving. [See Section 6 2) for more details]

3.3. SIP-adus Workshop

The SIP-adus Workshop have been held since the first phase of SIP as an international conference, in order to enhance Japanese initiatives in the context of automated driving research and development, to promote the technologies developed in

Japan, and to contribute harmonization for international standardization (Fig.2). It has been held annually in November since 2014 (was held in October in 2022), and the Workshop is now recognized as an international conference on automated driving research hosted by Japan.

The Workshop was composed of plenary sessions open to the public and breakout sessions that aim for deeper discussions between invited experts, and the sessions consisted of the focus international research themes. Due to the COVID-19 pandemic, the SIP-adus Workshop 2020 and 2021 were held as a web-based conference, while the SIP-adus Workshop 2022 was held as an in-person conference in Kyoto. [See Section 6 1) for more details]

Fig.2: Memorial photograph taken at the 2022 SIP-adus Workshop

3.4. Deploying globally opened, Large-scale Field Operational Test environments

Large-scale FOTs were conducted in the Tokyo waterfront city area encompassing the Tokyo waterfront subcenter area, the Haneda airport area, and the Metropolitan expressway that connects Haneda airport and the waterfront city area. The purpose of this FOT was to find solutions to technical issues for application of infrastructure cooperative data, such as merging lane assistance, traffic jam information, and traffic signal information, as well as to encourage the development of automated vehicles, enhance international cooperation and standardization, foster public acceptance, and promote advanced technologies.

Deploying a globally opened test environment to conduct the FOTs in the Tokyo waterfront area enabled automobile manufacturers and suppliers from outside Japan to participate in the FOTs. Basic technologies for the realization of automated driving were validated in the real traffic environment on public roads.

3.5. Activities for International Standardization

SIP-adus is strengthening collaborations with standardization bodies to bring products and services into global markets smoothly and quickly. We are working with organizations such as the Japan Automobile Manufacturers Association (JAMA) and the Society of Automotive Engineers of Japan (JSAE), as well as the Japan Auto Parts Industries Association (JAPIA), the Japan Electronics and Information Technology Industries Association (JEITA), the UTMS Society of Japan, the Association of Radio Industries and Businesses (ARIB), and the ITS Info-communications Forum (ITS Forum) to promote standardization based on both "de jure" standards in ISO, IEC, and ITU etc., and "de facto" standards through cooperation with global industry standardization bodies.

4 Future Initiatives Toward Promoting International Cooperation

In SIP-adus, with the view that international cooperation is important, an international cooperation framework was established, and international cooperation activities were carried out at the both expert and government level, as well as assignments of theme leaders in charge of international cooperation on focus themes, and an assignment of collaborative research coordinator.

Activities toward social implementation of automated driving technologies have been carried out worldwide, like the U.S., Europe, and China, but these are mostly still at the pilot test phase. In order to realize and spread the automated driving technologies into the society, it is important to share lessens and learned through various pilot activities in the world, and to harmonize internationally in cooperative areas, including international standardization.

In promoting international cooperation activities, it is essential to build trusted relationships with overseas governments and research institutions, and continuing and developing the relationships with overseas governmental institutions and experts built through the international cooperation activities under the SIP-adus are expected after the second phase of SIP-adus. In fact, the German Federal Ministry of Education and Research and Directorate-General for Research and Innovation of the European Commission, which have been engaged in Japanese-German and Japanese-EU cooperation activities, have strongly requested the continuation of cooperation activities with Japan after the completion of the second phase of SIP-adus.

Since the beginning of the second phase of SIP, SIP-adus has been targeting to build a continuous international cooperation framework, and it has been studied and made an arrangement to establish the new association which enables to discuss and coordinate with overseas research institutes by government-industry-academia collaboration and serves as an window for international cooperation activities regarding automated driving technologies in Japan, by utilizing an academia network in "Alliance for promoting mobility innovation". As a result, "Mobility Innovation Alliance Japan" was newly established in July 2022, taking over the framework of "Alliance for promoting

mobility innovation" under the SIP-adus. Mobility Innovation Alliance Japan aims to enhance research activities about mobility innovation in Japan, which contribute to the social economic growth and academic research development.

Mobility Innovation Alliance Japan co-hosted the SIP-adus Workshop held in Kyoto in October 2022 with the Cabinet Office, NEDO, and Doshisha University. In addition, They also co-hosted the "Mobility Business Innovation Contest (M-BIC) 2022" which was held as a side event of SIP-adus Workshop 2022, with Mobility innovation collaborative research organization, the University of Tokyo (UTmobI) and Mobility research center, Doshisha University.

In the future, the new association "Mobility Innovation Alliance Japan" will be expected to serve for the related government ministries and agencies as a one-stop service window for international research activities related to automated driving, etc., with overseas institutes. They are also expected to act as a bridge between industry-government and academia, as well as expanding academia network, and to promote international collaborative research activities by considering and proposing new international research topics.

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1) SIP-adus Workshop

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(Abstract) SIP-adus Workshop 2022 was held in Kyoto on October 11. It was the ninth workshop since 2014, and the last workshop of SIP-adus. The event saw researchers meet face-to-face and discuss issues for the first time in three years. This international conference, organized by Japan and established to communicate information and research results to stakeholders in Japan and overseas, to build networks with overseas researchers, as well as to develop leaders capable of acting in an international capacity, has seen its profile increase with every iteration and has served to facilitate SIP-adus (Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services) international cooperation activities. Cooperative ties formed through this workshop among researchers in Japan and overseas, and newly developed connections with younger generations, will be carried on in the future development of automated driving technologies and the process of their social implementation.

Keywords: SIP-adus Workshop, international cooperation, international conference, Japanese-German cooperation, Japanese-EU cooperation

1 About the SIP-adus Workshop

1.1. SIP-adus Workshop Aims

The SIP-adus Workshop has five main goals: 1. Communicating the results of automated driving technology-related R&D in Japan to overseas stakeholders; 2. Sharing the latest information about the development of these technologies overseas; 3. Building a network among those engaged in automated driving technology development in Japan and overseas; 4. Communicating this information to stakeholders in Japan; and 5. Developing leaders who can act in an international capacity through these activities.

One of the four pillars of the SIP-adus program is strengthening international cooperation. Because of the need to proliferate products in the vast and growing domestic and international automobile markets, and to further strengthen competitiveness, automated driving technologies will need to be more readily accepted not just in Japan but also overseas. Key to this endeavor will be active efforts by Japan to internationally standardize the technologies it develops and to communicate those technologies to the international community. SIP-adus therefore exists to establish themes to be prioritized for international cooperation, appoint international cooperation coordinators to further this cooperation, exchange information beyond borders with respect to internationally-shared issues concerning automated driving, internationally standardize solutions to these issues in Japan, and thoroughly share information about activities and achievements. The SIP-adus Workshop was launched as an international conference organized by Japan to promote these activities by working to achieve the five goals mentioned above.

Held for the first time in 2014, the SIP-adus workshop saw experts come together from Japan and overseas every autumn up until FY2022, the final year of SIP-adus, raising its international profile with every iteration. Through the workshop, automated driving experts gathered under one roof and worked to achieve these goals, broadly sharing information and building international networks through discussions about R&D and service commercialization.

1.2. SIP-adus Workshop Structure

The SIP-adus Workshop comprises the Plenary Session, which is open to the public, and the Breakout Workshop, where invited experts can discuss issues.[(1)(2)]During the Plenary Session, speeches are given by ministers of state in charge of SIP, government officials from the U.S. and Europe, and the SIP-adus program director, and experts present on research in their fields. Ministries and agencies also talk about the national policies in their respective departments. In the Breakout Workshop, information shared during the Plenary Session feeds deeper discussions through sectional meetings covering different areas of expertise. Moderating the three days of presentations and discussions are the SIP-adus international cooperation coordinator, as well as leaders of different key

themes for international cooperation. Providing overall leadership for the Breakout Workshop, these individuals leverage the connections they form every year with researchers in Japan and overseas and arrange for participation by speakers and discussion members.

2 History of the SIP-adus Workshop

2.1. Workshops up to FY2019

Starting with the first session in November 2014, the SIP-adus Workshop has seen its profile and number of participants grow every year. The nationalities of its participants has also grown diverse: the 420 participants from nine countries in 2014 grew to more than 500 people from 23 countries and regions in 2019. Between 50 and 60 people give talks at the Plenary Session every year, with about half coming to speak from overseas. These international cooperation coordinators and theme leaders for key issues concerning international cooperation actively participated in Japan-EU and Japan-German research cooperation and international standardization activities in their fields, as well as in international conferences held overseas. These efforts boosted SIP-adus's profile and forged important relationships.

This cooperation revolved around key themes for the SIP-adus international cooperation for that year. The first session focused on five themes: the Dynamic Map, Human Factors, Next Generation Transport, Connected Vehicles, and Impact Assessments. Since then, the discussion themes have been evolved by adding technical domains such as Security, Connected Vehicles and FOTs (Field Operational Tests), and by including Regional Activities to show study trends in different countries and regions, primarily those in Europe and the U.S., as appropriate to overall program activities and R&D priorities. In addition to the plenary session, a poster session was held to share achievements made in each field, along with a test ride of automated vehicles in certain years. (Fig.1) These events served to communicate the results of Japan's automated driving technology developments and SIP-adus.

Fig.1: From the FY2015 test ride

2.2. Changes Brought by COVID-19

In FY2020 and FY2021, the decision was made to hold the workshop online as COVID-19 caused restrictions on people's movement inside and outside the country. The two-day plenary session was conducted in Japanese and English with consideration for Japan time as well as U.S. and European time, with the goal to make it easier to participate in and watch. A video recording of the workshop was made available for a one-month period afterwards.More than 1,000 people watched these online events as they happened, and nearly 45% of those who participated in the 2021 workshop (Fig.2) did so for the first time. Despite the inability to meet face-to-face, these workshops ended up getting out the SIP-adus's message to more people than ever before, while highlighting the latent needs of people who had always been interested in the workshops but could not make it to the venue. Moreover, the 2020 workshop, which consisted only of the Plenary Session, reconfirmed the importance of holding the Breakout Workshop, where experts can get into more in-depth conversations. However, participants agreed that the online sessions, while allowing for communication through one's online network, did not allow for participants to understand one another as smoothly or deeply as they could face-to-face.

Fig.2: All speakers at the SIP-adus Workshop 2021 (held online)

2.3. Final Year of the Second phase of SIP-adus (2022)

In FY2022, the best way to hold different events is being reevaluated with a nod to COVID-19's having become endemic. For the SIP-adus Workshop 2022, the event was held in person for the first time in three years in order to bring back face-to-face meetings. Rather than Tokyo, where past workshops have been held, the event was held in Kyoto, an international city that represents Japan. Both the Plenary Session and Breakout Workshop were held with an emphasis on facilitating direct interaction among participants. (Fig.3) This workshop emphasized communication among experts based on the experience of holding two workshops amid the COVID-19

outbreak, and prompted the decision to provide video of the Plenary Session later online for the many who were unable to make it to the venue.

In addition to the seven themes of Human Factors, Impact Assessment, Dynamic Map, Connected Vehicles, Cybersecurity, Safety Assurance, Service and Business Implementation, added to the program this year — the final year of the second phase of SIP-adus — was a panel discussion by research representatives from the U.S., Europe, and Japan that looked back on nearly 10 years of automated driving development and looked forward to future developments. Additionally, Mobility Business Innovation Contest 2022 (M-BIC)[3] Interim presentation session was co-hosted at the venue and mutually shared event announcement. Including event guide support by students of Doshisha University as workshop venue, these efforts served to build new connections with a generation of people who will drive greater involvement with automated driving.

3 SIP-adus Workshop Achievements and Legacy

Through nine iterations held from 2014 during the first phase of SIP-adus to 2022 during the second phase of SIP-adus, the SIP-adus Workshop has become widely known worldwide as an international conference for automated driving in Japan. Throughout this time, SIP-adus members have monitored social developments and accordingly re-examined how the event should be held and what its content should be, while continuing to share information every year about current R&D trends and communicating the projects' achievements. Theme leaders convened researchers for each topic of discussion and managed these discussions, and relationships built through these discussions resulted in new networks for conducting subsequent research and workshops. These outcomes represent a full achievement of the original goals for the SIP-adus Workshop.

Although FY2022 will be the final year for SIP-adus Workshops, these achievements will be perpetuated not only in future meetings but also in the relationships among researchers and the technical research conducted in Japan's automated driving industry.

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Fig.3: From the SIP-adus Workshop 2022

2) Japanese-German and Japanese-European Cooperation

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(Abstract) As intergovernmental international cooperation activities in the second phase of SIP-adus, collaborative activities with the German Federal Ministry of Research and Education (BMBF) and Directorate-General for Research and Innovation (DG-RTD) of the European Commission were conducted by receiving offers for joint research through the frameworks of Japanese-German cooperation and of EU funded project. In the Japanese-German cooperation, a steering committee that made decisions on collaborative research activities in the field of automated driving, approved joint research plans in the four research fields of human factors, socioeconomic impact, safety assurance, and cybersecurity related to automated driving technology, and collaborative activities were conducted. In the Japanese-EU cooperation, offers were received to cooperate with projects under Horizon 2020, an European Framework Programme for Research and Innovation funded by the European Commission, and cooperation activities with mainly three projects under Horizon 2020 were conducted.

Keywords: Japanese-German cooperation, Japanese-EU cooperation, Horizon 2020

1 Background

In the second phase of SIP-adus, enhancing international cooperation was defined as one of the four major activity pillars. In response to the automated driving Field Operational Tests (FOTs) carried out globally and various international discussions, SIP-adus encouraged international joint research and other cooperation activities with overseas research institutes in the field of automated driving.

Many research projects regarding connected and automated driving, including the PEGASUS project under the initiative of German government and projects under Horizon 2020 Framework Programme for Research and Innovation, are carried out in Europe, and offer of joint research through the frameworks of Japanese–German cooperation and the EU funded project were received to SIP-adus. In response to these circumstances, the SIP-adus program established a framework to support intergovernmental cooperation activities and conducted international cooperation activities as the Japanese-German cooperation and Japanese-EU cooperation.

2 Overview of Japanese-German Cooperation

Japanese–German cooperation activities on automated driving were carried out between Japanese Cabinet Office and the German Federal Ministry of Education and Research (BMBF), based on the Joint Declaration of Intent on Japanese – German Cooperation of the Minister of State for Science and Technology Policy of Japan and the Federal Minister of Education and Research of the Federal Republic of Germany on the Promotion of Research and Development on Automated Driving Technologies on January 12, 2017.

In order to promote the research and development for automated driving technologies by Japanese-German cooperation, a steering committee was established to make decisions on Japanese–German cooperation activities for automated driving. The committee consists of related members, specialists, and other representatives of the Cabinet Office, Ministry of Economy, Trade and Industry in Japan, BMBF, and German Federal Ministry for Economic Affairs and Climate Action, as well as other Japanese and German agencies involved. An expert workshop for exchanging information and opinions among experts of related research fields, and a coordinating secretariat that arranged and supported the cooperation activities, were formed under the steering committee. Thus, the Japanese–German cooperative structure shown in Fig.1 was established.

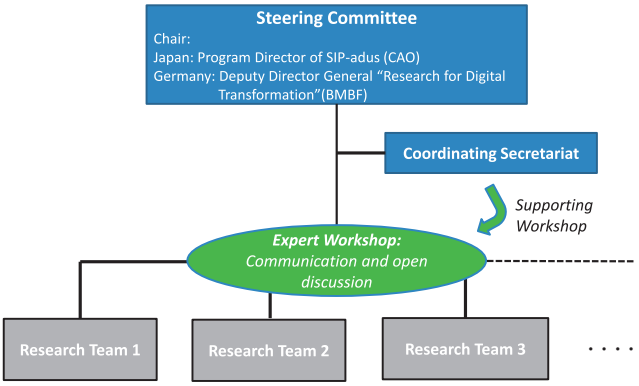

Fig.1: Japanese-German cooperation structure

The first Japanese-German cooperation expert workshop to discuss specific cooperative research topics was held in November 2017, by taking the opportunity of the SIP-adus Workshop. Since then, the workshops were held as an annually basis, and a total of six expert workshops were held by October 2022. In the workshops, experts from various research fields such as human factors, socioeconomic impact assessment and safety assurance of automated driving participated, and active discussions were held among the experts.

The first Japanese-German cooperation steering committee, which discussed specific collaborative research topics and approved cooperative research activities, was held in January 2019. Since then, a total of six meetings were held by January 2023.

In addition, in order to enable smooth communication between Japanese and German experts at each joint research topic, a list of contact persons for each research topic was jointly created and shared among related members in November 2019.

The Japanese-German cooperation activities have produced various outcomes in each research topic, including contributions to international standardization activities, joint book publications of research results, and exchanges of young researchers through joint workshops, that demonstrated the importance of Japanese-German cooperation, because both countries have automotive industries as a core industry. A joint brochure to summarize the research cooperation outcomes has been published.

2.1. Japanese-German Cooperation in Human Factors and Socioeconomic Impact Assessment

Through the expert workshops held on November 2017 and September 2018, discussions were held regarding research and development of human factors and socioeconomic impact assessment of automated driving. As a result, the joint research plans for those two topics were approved at the first steering committee in January 2019.

In the field of human factors related to automated driving, Japanese and German academic researchers jointly investigated differences in interpreting communication signs between Japan and Germany, and how to address the differences when it exists, with regard to communications with outside environments which were essential to automated vehicles.

In the field of socioeconomic impact assessment, researchers worked on developing methodologies to scientifically and quantitatively calculate the impact of the safer and more efficient traffic flow, reduction of traffic congestions, and decreasing fatal traffic accidents that would be brought by the realization of automated driving technologies, as well as researching differences between Japan and Germany in terms of fostering of public acceptance for automated driving technologies.

2.2. Japanese-German Cooperation in Safety Assurance and Cybersecurity

At the second steering committee in November 2019, members agreed to study the opportunities for new joint research topics of safety assurance and cybersecurity, addition to the above-mentioned joint research activities. And joint research plans for both topics were approved at the third steering committee in May 2020.

In the field of safety assurance, researchers developed evaluation methods for validation, modeling, and simulation to assure the maximum level of safety for automated driving.

In the field of cybersecurity, researchers developed methods to detect and eliminate potential security threats of modern automated vehicles at an early stage, starting already in the development process.

3 Overview of Japanese-European Cooperation

Based on the recommendations for international cooperation with non-European nations including Japan, the U.S., and Asia and Oceania countries in the Horizon 2020, EU Framework Programme for Research and Innovation of the European Commission, the meeting between SIP-adus and Directorate-General for Research and Innovation (DG-RTD) of the European Commission was held to exchange the opinions for future cooperation in April 2018. Since then, the opportunities of specific Japan–EU cooperation activities were studied.

At the meeting with the European Commission (DG-RTD) in November 2019, it was agreed to consider cooperation opportunities by coordinating between already existing European Horizon 2020 projects and SIP-adus research projects, and since then, cooperation activities were conducted with the three Horizon 2020 projects described below.

Different from the Japanese–German cooperation, the Japanese–EU cooperation did not intend to establish new joint

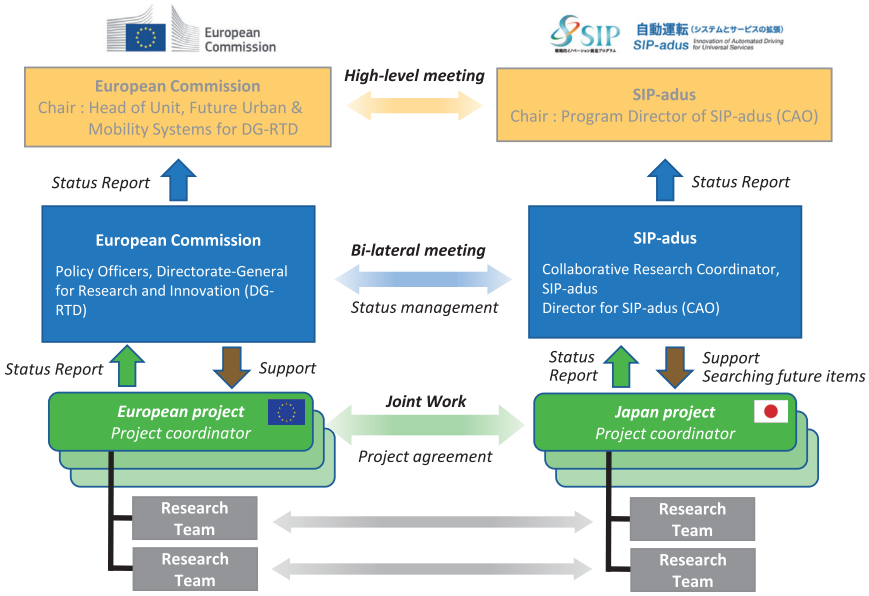

Fig.2: Japanese-EU cooperation structure

research projects. It featured promoting cooperation activities by coordination between existing Horizon 2020 and SIP-adus projects.

In order to promote Japanese-EU cooperation activities, the cooperative structure shown in Fig.2 was agreed with the European Commission (DG-RTD) to enable the coordinating secretariats to work together for monitoring and supporting cooperation activities based on coordination between Japan and EU projects.

The first meeting between the coordinating secretariats was held in May 2020, and subsequently held regularly on a quarterly basis. In the meeting, the latest status of cooperation activities between projects was shared and the opportunities for potential new cooperative research areas were discussed. The first high-level meeting including related government officials was held in March 2021, with the release of the first Annual Status Report 2020, which was summarized the Japanese-EU cooperation activities in 2020. And the second and third high-level meeting were held in July 2022 and February 2023, respectively. An Annual Status Report was issued annually since 2020.

In addition, a joint session with the European Commission (DG-RTD) was planned and held at the ITS World Congress to publicize the Japanese-EU cooperation activities. The joint sessions were held in Hamburg, Germany in 2021 and in Los Angeles, the United States in 2022, and the initiatives of the SIP-adus program and the Japanese-EU cooperation activities were presented.

3.1. Cooperation with the European HADRIAN Project

In the field of research and development of human machine interfaces (HMI) to enhance the safety of automated driving, SIP-adus experts of human factors research project regularly exchanged the information with experts of the European HADRIAN project. A joint workshop was held in September 2022 to exchange views among the experts.

3.2. Cooperation with the European HEADSTART Project

In the research field of safety assurance, cooperation activities with the European HEADSTART Project were conducted through the agency of the European Commission (DG-RTD). Since September 2020, meetings were held jointly with the Ministry of Economy, Trade and Industry-directed SAKURA Project to exchange information and discuss specific future cooperation topics related to safety assurance.

As an outcome of the cooperation activity, a white paper towards the harmonization of safety assessment methods of automated driving was published jointly by the European HEADSTART Project, the SAKURA Project, and the SIP-adus program in December 2021.

3.3. Cooperation with the European SHOW Project

In the research field of realization of automated driving services in urban areas, the Mobility Innovation Collaborative Research Organization, the University of Tokyo (UTmobI) and ITS Japan concluded a non-disclosure agreement (NDA) with the European SHOW project, which conducts large-scale demonstrations of mobility services focused on urban areas in September 2020. In October 2021, an memorandum of understanding (MOU) was concluded among the members, and cooperation activities with the SHOW project are currently ongoing.

Joint workshops were held in June and July 2022 to exchange views and opinions among experts on issues for the practical

realization of Level 4 automated mobility services.

4 Towards the Future

In the second phase of SIP-adus, the Japanese-German and Japanese-EU cooperation activities were conducted under difficult circumstances like no face-to-face meetings allowed due to travel restrictions caused by COVID-19. Despite difficult circumstances, by utilizing online conferences and joint workshops, etc., lots of exchanges and cooperation activities among experts were successfully conducted, and various outcomes including the exchange of research data, joint book publications, and the publication of white papers were obtained.

In fact, the German Federal Ministry of Education and Research and Directorate-General for Research and Innovation of the European Commission, which have been engaged in Japanese-German and Japanese-EU cooperation activities, have strongly requested the continuation of cooperation activities with Japan after the completion of the second phase of SIP-adus. It is expected that the trusted relationship with Japan built on the cooperation activities will be maintained, and the Japanese-German and Japanese-EU cooperation activities will continue and expand beyond the second phase of SIP-adus.

In Europe, the Horizon 2020 framework program for research and innovation was finished in 2020, and a new framework program for research and innovation, Horizon Europe was launched in 2021. The Horizon Europe program follows the Horizon 2020 approach of encouraging international cooperation with Japan and other countries outside Europe, and since June 2022, various research and innovation programs in the field of automated driving have been launched under the framework of Horizon Europe. New cooperation activities with the Horizon Europe projects will be expected through the relationship built between Japan and Europe.

Although the current cooperation structure will once terminate with the completion of the second phase of SIP-adus activities, it is expected that a new cooperation framework will be established to continue the activities of the Japanese-German and Japanese-EU cooperation.

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3) Dynamic Maps

Satoru Nakajo (The University of Tokyo)

(Abstract) International cooperation activities for dynamic maps are based on the results of SIP-adus (Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services) research and development in Japan. Their main purpose is to make the activities and R&D results related to SIP-adus , especially dynamic maps, known to the world, to obtain feedback on them, and to ensure consistency with international standards.Our activities can be broadly broken down into presenting our work at international conferences etc., international standardization activities, industy-wide alignment activities, and Japan-USA-Europe trilateral cooperation activities. Our activities during the second phase of SIP-adus had included presenting our work at several international conferences, including the ITS World Congress; establishing four international standards, ISO17572-1, 4 (location reference methods) and ISO20524-1, 2 (geographic data file); formally participating as a steering member of the OADF (Open AutoDrive Forum), an industry standardization activity related to digital maps; and achieving results in the implementation of SIP-adus FOTs (Field Operational Tests) based on specifications from ADASIS (Advanced Driver Assistance Systems Interface Specification Forum), another organization participating in the OADF.

Keywords: Road traffic environment data, location referencing methods, digital map, international standards, OADF

1 Overall undertakings

The main purpose of the international cooperation activities relating to dynamic maps is to make the activities and R&D results of SIP-adus, especially dynamic maps, known to the rest of the world, and to obtain feedback on them.

Specifically, four activities have been conducted: (1) presentations at various international conferences, (2) international standardization activities, (3) industry-wide alignment activities, and (4) Japan-USA-Europe trilateral cooperation.

In regard to presentations at various international conferences, SIP-adus has made presentations at numerous such conferences, including the ITS World Congress. In regard to international standardization activities, several items supported by SIP-adus have now become international standards. Specifically, four of them; ISO17572-1, 4 (location reference methods) and ISO20524-1, 2 (geographic data file). In addition, TS22726-1, 2 (semi-dynamic information and map database specifications for applications in automated driving systems) has been proposed as a new item for standardization. In regard to industry-wide alignment activities, we have continuously participated in the OADF events that are held several times a year, explaining the progress of SIP-adus to the other participants, and have also participated in the OADF Steering Committee, which meets around once a month to discuss the direction of OADF management. Furthermore, we have concluded a memorandum of understanding with ADASIS, one of the other organizations participating in the OADF, to disclose specifications for use in the SIP-adus FOTs, and then conducted FOTs using the ADASIS specifications and provided feedback on the results. In regard to Japan-USA-Europe trilateral collaboration activities, we regularly exchanged information with contacts in Europe and the USA in the Physical and Digital Infrastructure SWG, which is itself one of the activities in this arena.

2 Presentations at international conferences

During the first half of the second phase of SIP-adus, we made presentations at the following international conferences. In each presentation, we explained the positioning of dynamic maps in SIP-adus, the results of the research and development to date, and an overview of the activities in the second phase.

In particular, we highlighted how dynamic maps have been focusing on dynamic information coordination during the second phase of activities. Our explanations emphasized that various FOTs are being conducted based on the idea of integrally

handling not only static maps but also dynamic information.

- 2018 ITS World Congress, Copenhagen
- 2019 AVS, San Francisco
- 2019 ITS World Congress, Singapore
- 2020 International Conference on HD Maps for Autonomous Vehicles, Taipei (video participation)
- 2021 ITS World Congress, Hamburg (video participation)
- 2022 ITS World Congress, Los Angeles

3 International standardization activities

3.1. Summary of activities for the second phase of SIP-adus

In regard to international cooperation activities for dynamic maps, we have had an ongoing involvement in the ISO/TC204/WG3 (ITS geographic information) since the first phase of SIP-adus. ISO/TC204/WG3, which is a TC204 committee that considers ITS international standards, mainly considers international standards for digital maps and spatial information. SIP-adus activities have resulted in four international standards, ISO17572-1, 4 (location reference methods) and ISO20524-1, 2 (geographic data files). Furthermore, TS22726-1, 2 (semi-dynamic information and map database specifications for applications in automated driving systems) was proposed as a new item for standardization. The following is an overview of each international standard.

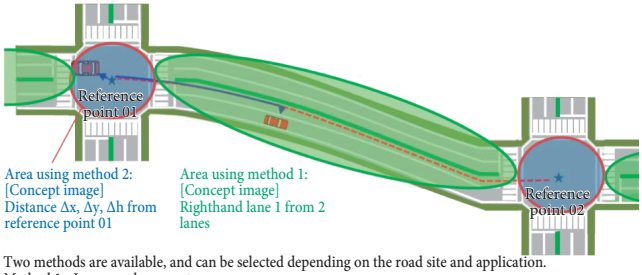
3.2. ISO 17572-1, 4 (location referencing methods)

A location referencing method is a standard for representing locations when exchanging information between different applications and map databases. When exchanging traffic information between different systems, the objective is to be able to know where the location is even if different map databases are used.

Pre-coded profile (ISO17572-2) and Dynamic profile (ISO17572-3) standards have been established by past activities. The pre-coded profile uses an ID (road link, etc.) defined in advance for shared use by all users, and the location is referenced based on this ID. It is used in such systems as the VICS (Vehicle Information and Communication System) and the RDS-TMC (Radio Data System, Traffic Message Channel) used in Europe. The dynamic profile references locations by transmitting latitude, longitude, and additional information.

In addition to the above, a fourth profile, "Precise Relative Location Referencing for Geographic Databases" was approved in April 2016 to enable high-precision location referencing for cooperative/automated driving systems, and work started on this as NP 17572-4. This proposal was made by Japan based on the discussions as part of SIP-adus. After a process of standard review and deliberation, an ISO (ISO 17572-4) was issued in April 2020.

Two methods are specified in the Precise Relative Location Referencing Method, as shown in Fig.1. Method 1 is lane number counting, which is applied to road sections where lanes exist and is used to identify the lanes. Method 2 is a difference measurement from a reference point and is applied to road sections with unclear lane definition (such as within intersections and before or after toll booths). In order to represent an exact location, these are always applied within around 200 meters of the reference point. ISO17572-4 was issued as an ISO in April 2020. Furthermore, based on the establishment of this new standard, ISO17572-1, which defines the basic concept of location referencing methods and any documentation to be referenced, was revised to explicitly position the Precise Relative Location Referencing Method as one of the location referencing methods specified by international standards. The revised version of ISO17572-1 was issued in July 2022.



Two methods are available, and can be selected depending on the road site and application.
Method 1: Lane number count
Applicable to road sections where lanes are present
Utilized to identify lanes
Method 2: Difference measurement from a reference point
Applicable to road sections with unclear lane definition (such as at intersections and before/after toll booths)
Applicable in the area within 200m from the reference point
Utilized as a relative positional representation with respect to the road (<25cm positional accuracy)

Fig.1: Basic concept of the Precise Relative Location Referencing Method[1]

3.3. ISO20524-1, 2 (geographic data file)

The geographic data file (GDF) has mainly been used for car navigation systems. With the emergence of further applications for it, such as cooperative ITS, multimodal navigation, and automated driving systems, the need to revise it has increased. Taking this into account, PWI 20524 was approved in October 2014, and work to revise GDF 5.0 has begun. Japan has taken the lead in discussions on automated driving systems, based on input from Japan, Europe, and the USA. Finally, the ISO for part 1 was issued in April 2020, and the ISO for part 2 was issued in October 2020.

3.4. TS22726-1, 2 (quasi-dynamic information and map database specifications for applications in automated driving systems)

TS22726 details specifications for handling static and quasi-

dynamic geographic data in a unified manner for use in automated driving. They have been proposed by Japan based on such data as the results of the FOTs. As of September 2022, both are still at the WD (working draft) stage.

4 Industry-wide alignment activities

SIP-adus has continuously participated in OADF, a cross-domain platform for standardization for digital maps related to automated driving. OADF is a forum started in 2015 for the sharing of information among standards organizations. SIP-adus participated in the 5th conference (Beijing) in 2016, where it had individual meetings with the chair, and has been presenting continuously since the 6th conference (Brussels). In 2017, SIP-adus hosted the 8th meeting in Tokyo together with the SIP-adus Workshop. After these activities, Japan became a member of the Steering Committee in 2019.

Currently, the OADF has the following six organizations as official members, as shown in Fig.2.

- ADASIS: Advanced Driver Assist Systems Interface Specification
- NDS: Navigation Data Standard
- SENSORIS: Sensor Interface Specification
- SIP-adus
- TISA: Traveler Information Services Association
- TN-ITS: Transport Network Intelligent Transport Systems

In addition, there were ongoing discussions concerning the OpenDRIVE® and OpenSCENARIO® simulation standards led by ASAM (Association for Standardization of Automation and Measuring Systems).

The OADF itself does not set standards, and its main purpose is to exchange information among the participating organizations. SIP-adus is not a standardization body, but has participated in order to provide reference results for various industry standards.

Based on the ongoing OADF discussions, SIP-adus signed a memorandum of understanding with ADASIS in 2019 to receive disclosure of ADASIS specifications (version 3) to study their feasibility for use in the SIP-adus FOTs. SIP-adus then proceeded to utilize ADASIS specifications in the SIP-adus FOTs, while exchanging opinions with ADASIS as appropriate, and conducted evaluation and feedback of the evaluation results to ADASIS.

5 Japan-USA-Europe trilateral cooperation activities

The Japan-USA-Europe Trilateral Cooperation Activities are government-led international cooperation based on a memorandum of understanding signed by the European Commission and the U.S. Department of Transportation in 2009, and by the Japanese Ministry of Land, Infrastructure, Transport and Tourism in 2010 and 2011 regarding cooperation in the field of ITS between Japan, the USA, and Europe.

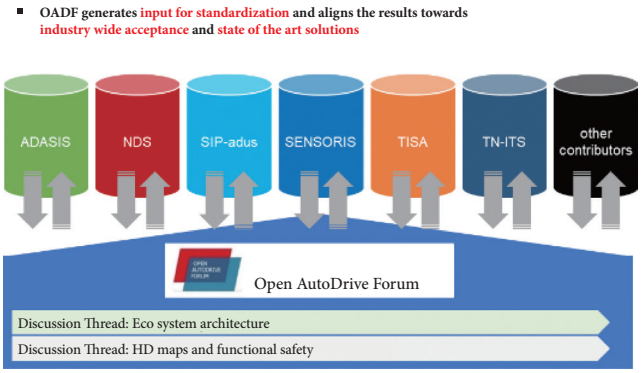


Fig.2: Positioning of SIP-adus in OADF[2]

SIP-adus has been participating in the initiatives related to automated driving and exchanging opinions regularly with contacts in Europe and the USA. One of the initiatives related to automated driving is the Physical and Digital Infrastructure SWG. As part of this activity, SIP-adus regularly reports to contacts in Europe and the USA on the dynamic map-related trends in SIP-adus, and receives information on the status of activities in Europe and the USA.

In previous years, meetings had been held in conjunction with the ITS World Congress, as well as various international conferences in the triad; from 2019 onwards, meetings were held online several times a year.

6 Conclusion

Through the international cooperation activities of SIP-adus, we have continuously lobbied international and industry standardization organizations, publicized Japan's activities and achievements, and as a result, our achievements have been incorporated into several international standards. This marks a very significant achievement for the future development of Japan's automated driving industry.

Although the activities of SIP-adus will be coming to an end, it would be desirable to utilize the relationships established in subsequent programs as required. In the future, automated driving, as one of the future mobility services, is expected to be further linked to other modes of transportation and various urban activities. We hope that the results of SIP-adus will be further utilized in a wide range of fields that make use of automated driving.

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4) Human Factors

Satoshi Kitazaki (National Institute of Advanced Industrial Science and Technology (AIST))

(Abstract) Human factors in automated driving are important factors related to public acceptance and safety of automated driving. Understanding humans can be positioned as foundational research in the cooperative area. During the first and the second phases of SIP-adus (Cross-ministerial strategic Innnovation Promotion Program (SIP) Automated Driving for Universal Services), Research questions, methods and results were actively shared and discussed through the international collaborations. The results were also brought to international standardization. This article introduces such activities.

Keywords: Human factors, HMI (human machine interface), international cooperation, trilateral cooperation, Japan-EU cooperation, Japan-Germany cooperation, international standardization

1 Background

Human factors in automated driving are important factors related to public acceptance and safety. In Level 2 and 3 automated driving, the driver still has a certain role even during automated driving. If the drivers is unable to fulfill this role, an unsafe situation can occur. Also, when intents of an automated vehicle with Level 3 or higher system are not understood by surrounding drivers or pedestrians in the mixed traffic, safety and efficiency of traffic can be degraded. This may also impede fostering public acceptance of the automated vehicles.

Human factors research in automated driving can be positioned as foundational research in the cooperative area. The research was conducted through frequent communication with the SIP-adus members from the academia, industry and the government. Research questions, methods and results were shared and discussed at international conferences and meetings to verify them. The results also contributed to international standardization.

Thia chapter introduces activities in international cooperations and standardization in the field of human factors in automated driving.

2 International cooperation

2.1. Japan-US-Europe trilateral cooperation

Activities were operated on the Human Factors sub-Working Group (HF-subWG) under the Automated Road Transport Working Group (ART-WG) in the trilateral cooperation framework agreed on by the governments of Japan,

Table 1: Trilateral cooperation Human factors sub-WG members

United States	
Stacy Balk, co-chair	NHTSA
Brian Philips	FHWA
Bobbie Seppelt	Ford
Dan McGehee	University of Iowa
Johan Engström	Waymo
Chuck Green	MIT
John Lee	University of Wisconsin
European Union	
Natasha Merat, co-chair	University of Leeds
Emma Johansson	Volvo trucks
Andreas Keinath	BMW
Anna Schieben	DLR
Klaus Bengler	TU Munich
Ludgrer Rogge	EC, DG R&I
Japan	
Satoshi Kitazaki, co-chair	AIST
Makoto Itoh	University of Tsukuba
Tatsuru Daimon	Keio University
Keisuke Ishii	Honda, JAMA
Observers	
Joanne Harbluk	Transport Canada
Peter Burns	Transport Canada
Mike Regan	University of New South Wales, Australia
Mandi Mees	National Transport Commission, Australia

US, and European comission . The HF-subWG is jointly chaired by Stacy Balk (NHTSA) for the US, Natasha Merat (University of Leeds) for Europe, and Satoshi Kitazaki (AIST) for Japan. It is comprised of several expert members from industry, academia, and government of each country. (Table 1)

The purpose of this cooperation is to (1) share the knowledge and information related to human factors in automated driving, (2) extract new human factor issues, (3) generate opportunities for research cooperation, and (4) joint authorship of research papers. The sub-working group meetings are held around once every three months, where members exchange information and discuss items (1), (2), (3) mentioned above. Also, at major international conferences in Japan, the US, and Europe, the members planned workshops and organized sessions, inviting more experts, to exchange informtion and discuss various issues. Regarding (4), the group published a paper about the Out-of-the-Loop concept for automated driving as a result of this cooperation in 2019.[1] Currently, the group is jointly writing a paper related to mental models of automated driving.

2.2. Japan-Germany Cooperation

The Japanese-German cooperation related to automated driving based on an agreement of the governments of Japan and Germany started for human factors in 2019. Five research institutions in Japan, National Institute of Advanced Industrial Science and Technology (AIST), University of Tsukuba, Keio University, the University of Tokyo, and Kumamoto University, which were the consortium members for the SIP-adus Human Factors research project cooperated with five research institutions in Germany, Technical University of Munich, Chemnitz University of Technology, Ulm University, Dresden University of Technology, and German Aerospace Center (DLR). The cooperation coordinators were Satoshi Kitazaki (AIST) for Japan and Klaus Bengler (Technical University of Munich) for Germany. Three research themes set in the SIP-adus human factors project (on-road communication and external HMI, driver-system interactions, and driver education and training) were also set in the German side (Table 2).

Japan and Germany alternately hosted two workshops every year between the first workshop in Tokyo in November 2019 and the last one in Tokyo in October 2022. Through the workshops, progress of the three themes was shared and discussed to brush up the research plans and to deepen understandings of obtained results for both sides. The theme 1 and theme 2 also included joint experiments. Scientific papers with co-authorship were planned to be published.

In addition to research cooperation, we held webinars in both Japan and Germany. The webinars spread the scope to areas beyond the cooperation research themes and invited students and young researchers for the aim of educating about human factors. Also, in order to appeal to cooperation activities, we communicated research results through organized discussions in the International Ergonomics Association (IEA, on-line) in June 2021.

Table 2: Japan-Germany cooperation research themes and member institutes

Research theme		Members in Japan	Members in Germany
1	One-road communication and eHMI	Keio University	Chemnitz University of Technology Dresden University of Technology Ulm University Technical University of Munich DLR
2	Driver-system interactions	AIST The University of Tokyo	Technical University of Munich Ulm University
3	Driver education and training	University Tsukuba Kumamoto University	Dresden University of Technology Technical University of Munich

2.3. Other international cooperations

The SIP-adus human factors research project had been also cooperating with two projects of EU Horizon 2020. MEDIATOR is an R&D project for new and safer interactions between the driver and the automated driving system. Satoshi Kitazaki, the project leader of the SIP-adus human factors research project, served as the advisory board member and provided advice based on the results of the SIP-adus project.

HADRIAN is an R&D project for Human Machine Interface (HMI) of automated driving that fluidly changes for safety depending on road environment and driver states. There had been regular meetings of the two project leaders. A workshop with members of the two projects was held in September 2022.

3 International standardization

Standardization activities for human factors and HMI of vehicles are being conducted in ISO/TC22/SC39/WG8. The Japanese representative organization to the WG8 is Human Interface (HI) Working Group of Japanse Society of Automotive Engineers (JSAE). Therefore, main members of the SIP-adus human factors research project participated in the WG8 as members of the HI Working Group.

For driver-automated system interactions, TR (Technical Report) 21959-1[2] and TR21959-2[3] published in 2018 and 2020 focused on safe transitions from automated driving to manual driving. TR21959-1 defines the transition process models for system and driver (Fig.1) and summarizes the concepts related to human factors in automated driving. TR21959-2, considerations in designing experiments to investigate transition processes, includes information about human factors and system parameters influencing takeover performance of the driver, construction of experimental

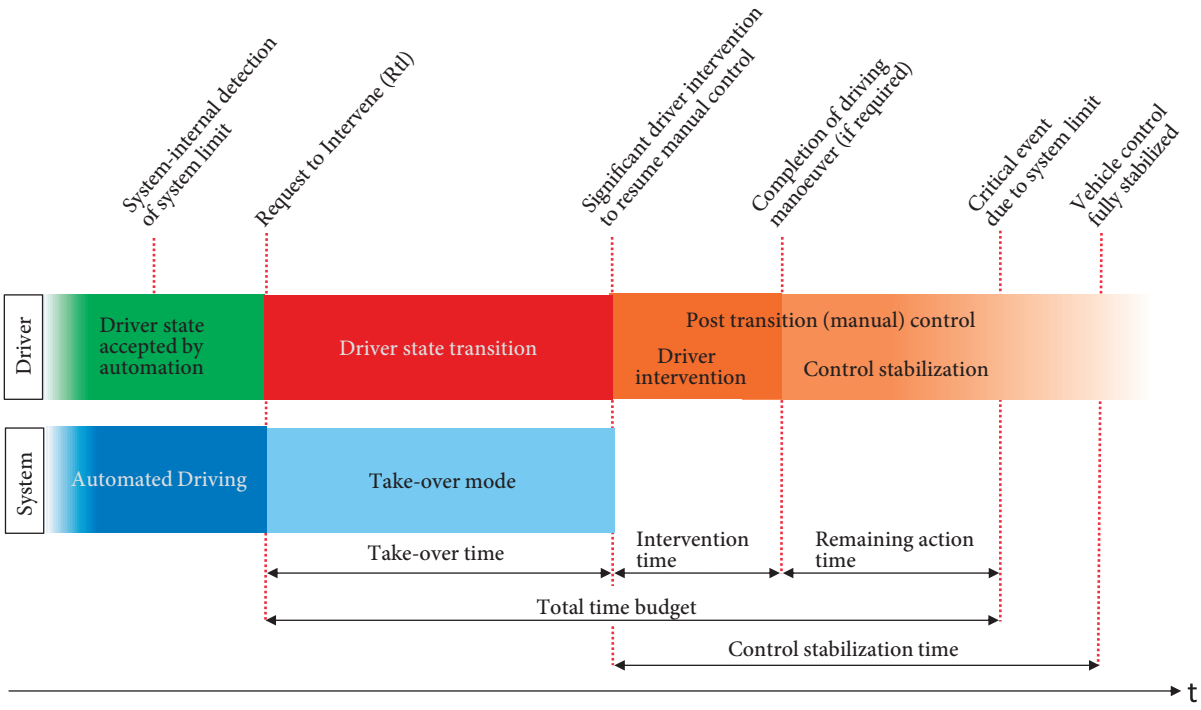

Fig.1: Transition process model (system-initiated transition) defined in ISO TR21959-1

scenarios, measurement indicators for performance evaluation and selection of experimental setups. Japanese delegates served as co-leaders with US delegates for both TR21959-1 and TR21959-2. The results from the human factors project of the SIP-adus Phase 1 were included in the two TR documents.

A Japanese delegate served as a co-leader of TS (Technical Specifications) 5283 project with a UK delegate. TS5283, ergonomic aspects of driver monitoring in automated driving, started in August 2020 as a 24 months project. The project members did not reach agreements on specifications and, therefore, category of the project was changed and the new project, TR5283-1,[4] started as a 24 months project in May 2022.

For on-road communication and external HMI of automated vehicles, the concept was published under US leadership in 2018 in TR23049.[5] Currently, PAS (Publicly Available Specifications) 23735,[6] which is related to eHMI design, is being conducted with a US leader. Japanese delegates are proposing to embed knowledge and results from the human factors projects in SIP-adus Phase 1 and Phase 2 into the document.

A new project on human factors in remote operations of automated vehicles[7] started in 2022 with leaders from US and Canada.

4 Conclusion

During the human factors projects in SIP-adus Phase 1 and Phase 2, the themes, methods, and results were repeatedly discussed and verified throuh the international cooperations. The achievements were presented internationally and contributed to international standardization. By doing so, presence of Japan was enhanced interntionally in the field of human factors in automated driving.

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5) Safety Assurance

Hideaki Sato (TOYOTA MOTOR CORPORATION)

(Abstract) As automated vehicles are expected to be put into practical use and be deployed in order to realize a safer, more efficient, and freer mobility society, there is an urgent need to develop safety assurance standards that ask what kind of concepts should be employed to make safety judgments that are acceptable to the public, as well as safety assurance methods that seek to comprehensively assure safety in diverse traffic situations. In Japan, DIVP®,(1) which is supported by the Cabinet Office in its efforts to build a safety assurance virtual environment, and SAKURA,(2) which is supported by the Ministry of Economy, Trade and Industry in its efforts to build a safety assurance scenario database, have launched, and the Japan Automobile Manufacturers Association, Inc. (JAMA), while presenting a technical strategy across these projects, is collaborating with industry, government, and academia to build safety assurance foundational technologies to support safety assurance standards and methods. Many research projects on safety assurance have been launched in various countries, and it is important to establish and operate a cooperative system that provides a lever for establishing international standards and criteria and common foundational technologies through close cooperation among such projects, both domestic and international.

Keywords: safety assurance, scenario-based, UN-R157, ISO 21448, ISO 34502

1 Issues in Safety Assurance Methodologies

Amid numerous dangerous situations faced when automated vehicles take over driving from people, safety guarantees, which guarantee a certain level of probabilistic reliability by conducting safety assurances through long-distance and long-term test evaluations in real traffic environments and by repeating improvements in a black box-like manner, are processes that are not transparent to the market because the evaluation results are not disclosed by the developing company or project. There are issues in the sufficiency and transparency of the evaluation scope in the evaluation process because, even when reviewing authorities perform audits, it is difficult for them to make absolute determinations of the sufficiency of safety guarantees. In addition, it is difficult to comprehensively cover a large number of driving situations and conduct sufficient safety assurances if the tests are conducted on a controlled test course under test conditions that have already been determined as part of the approval tests. To address the issues of safety assurance technology for automated vehicles, the following two projects have been launched in Japan to establish a common foundational elemental technology. (1) A project to study scenario-based testing, in which the conditions for safety assurance are logically structured and incorporated into evaluation scenarios, which are maintained and improved as a scenario database. (2) A project to construct a virtual environment technology to cover evaluation conditions that are too dangerous to be performed in the real world and innumerable evaluation patterns that cannot be completed in a realistic period of time in terms of efficiency.

1.1. Joint Domestic Promotion and International Cooperation on Safety Assurances

The Ministry of Economy, Trade and Industry is implementing SAKURA (Safety Assurance KUdos for Reliable Autonomous Vehicles) for scenario database construction for (1), and DIVP has been launched as a study under this SIP-adus for (2) to study a recognition virtual evaluation environment. In FY2021, a task force and steering committee were established to jointly promote the two projects in order to accelerate the development of safety evaluation technologies for automated driving, to improve the safety and development efficiency of Japan's automated driving technology, and to ensure its international competitiveness. (Fig.1.)

Fig.1: Joint promotion structure for automated driving safety assurances

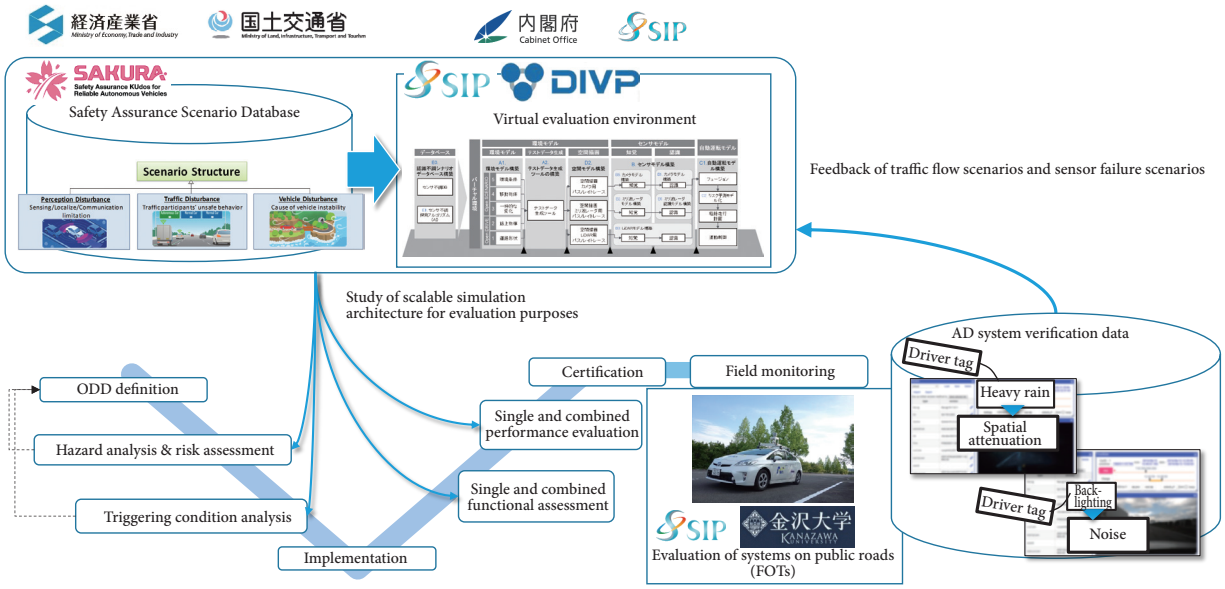

Fig.2: Aims of the joint promotion of automated driving safety assurances

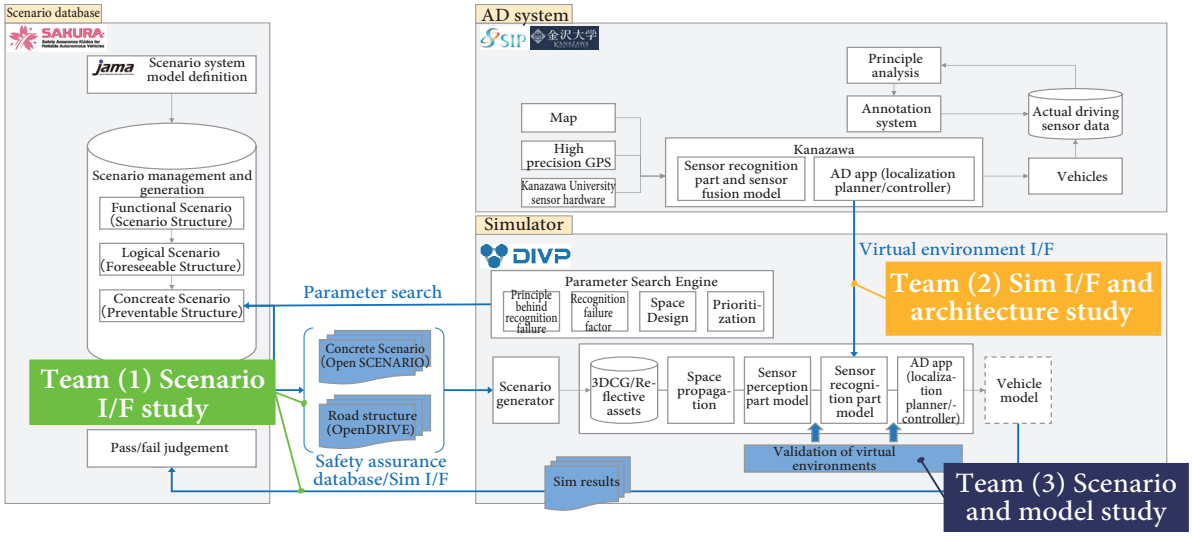

Fig.3: Overall view of safety assurance infrastructure

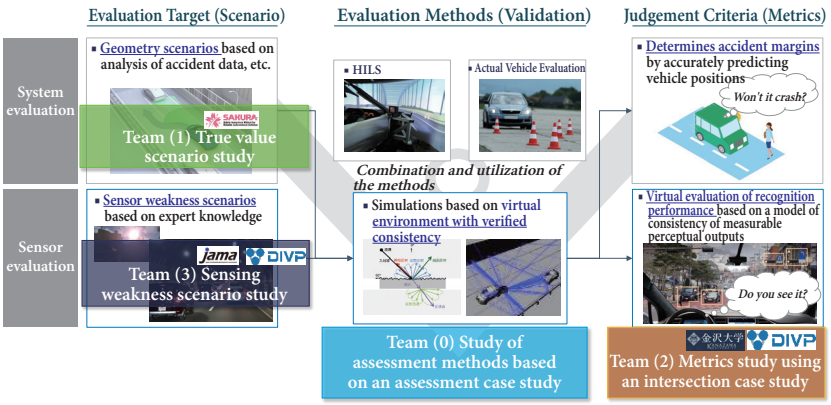

Fig.4: Issues to be studied in the safety assurance foundation

The aim of this joint promotion system is to improve the safety and development efficiency of Japan's automated driving technology and to ensure its international competitiveness by constructing a common foundation for safety assurances that is logically comprehensive, feasible, and transparent regarding the safety performance that automated driving systems should possess, and applying it to the actual development of automated vehicles. (Fig.2)

In the task force for joint promotion, teams are organized across projects to tackle technical issues necessary to apply the

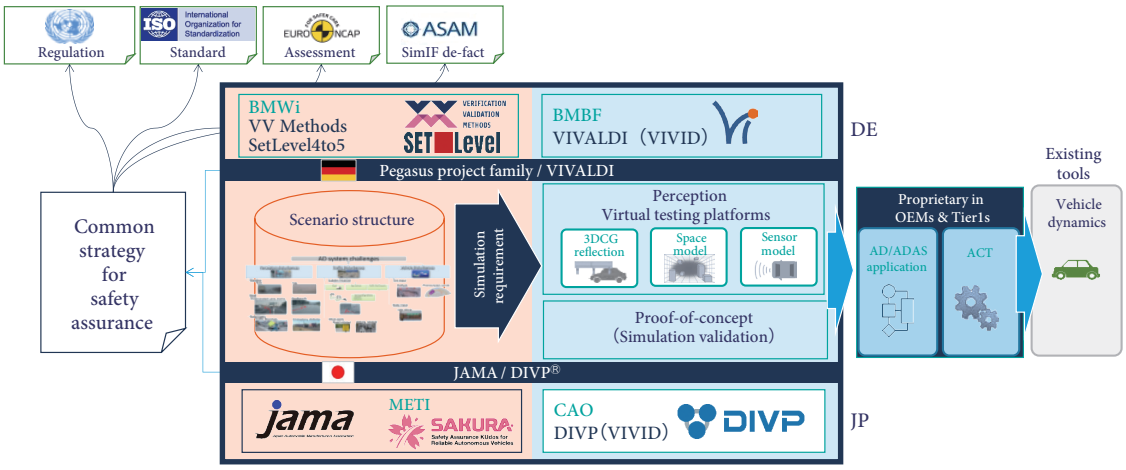

Fig.5: Strengthening Japanese-German cooperation through joint promotion

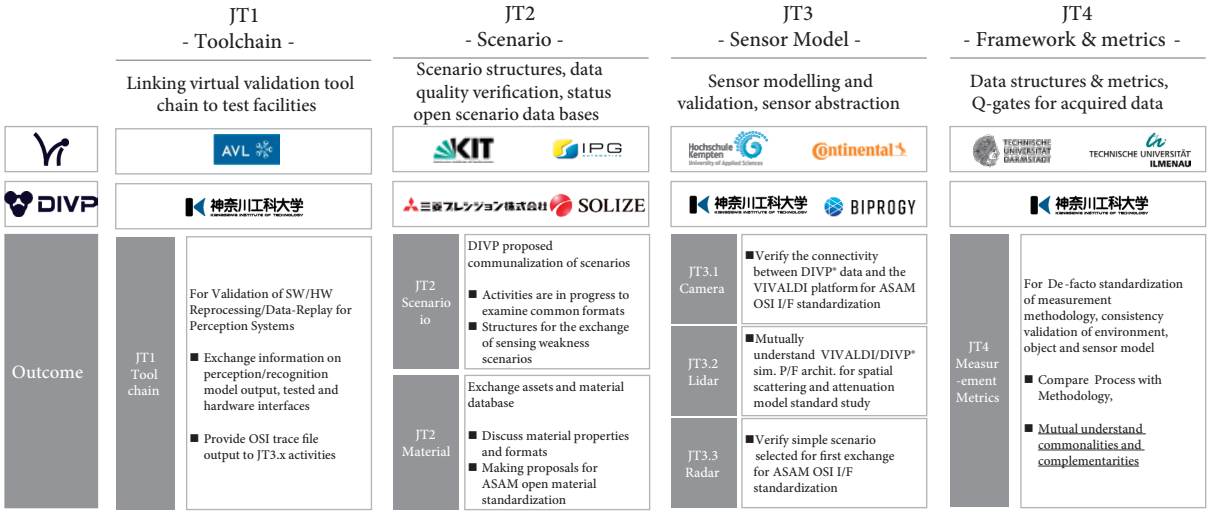

Fig.6: VIVID, a Japanese-German cooperative system for a safety assurance virtual environment

scenario database of SAKURA and the recognition virtual environment of DIVP to the development of actual automated vehicles. (Fig.3)

In addition, we are promoting research on safety assurance systems by adding the study of combinations of evaluation methods and the study of metrics to our research themes. (Fig.4)

Furthermore, the system under which the Japanese-German cooperation with Pegasus for scenarios and VIVALDI for virtual environments had been promoted has been integrated into the joint promotion system to strengthen the international cooperation between Japan and Germany. (Fig.5)

In particular, in the cooperation with the VIVALDI project (VIVID: Virtual Validation methodology for Intelligent Driving systems), activities are divided into expert task forces. The task forces are aiming to strengthen proposals for the standardization of safety assurance systems and simulation interfaces for automated driving in ISO, ASAM (Association for Standardization of Automation and Measuring Systems), etc., as shown in Fig.6, so that the technology can be easily combined with overseas sensor simulation environments to prevent it from becoming a technology that can only be used domestically.

The VIVID project has been promoting technical collaboration through regular meetings of expert task forces and Breakout Workshops of the SIP-adus Workshop, and held a symposium in Berlin in June 2022 with standardization organizations such as the Pegasus[3] family, a Japanese-German governmental organization, and ASAM, a non-profit organization promoting standardization of tool chains for vehicle development and evaluation. At the symposium, there was a high level of interest from non-VIVID experts in VIVID's activities, and it was a good opportunity to further strengthen Japanese-German cooperation. Of particular note, the proposal for ASAM OSI4.0 on DIVP's ray tracing interface was immediately approved and resulted in a successful outcome.

2 International Cooperation in Safety Assurance Standards

2.1. Background of International Standards Harmonization

Safety assurance standards are being actively discussed, including by ethics and legal experts. In the development of

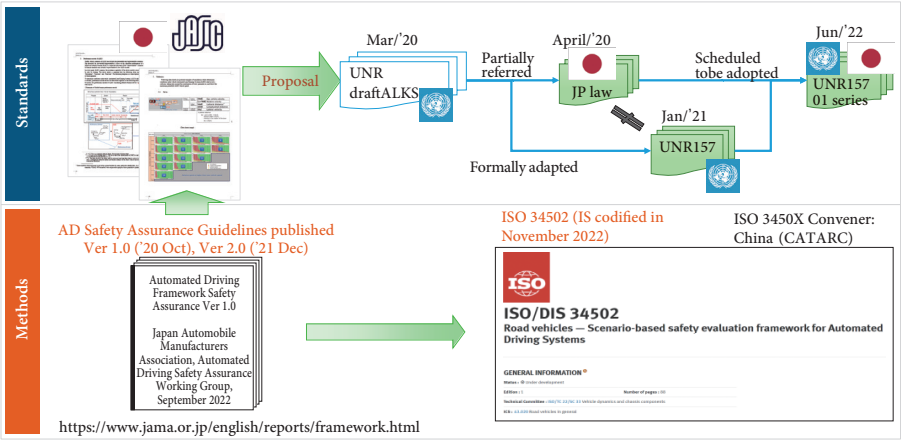

Fig.7: Japan's international standardization and international criteria initiatives

international standards for automated vehicles, an expert group (GRVA/VMAD) under the United Nations World Forum for Harmonization of Vehicle Regulations (WP.29) was established in 2018, and in 2020, the first UN regulation for type approval of Level 3 automated vehicles, UN-R157,[1] which covers low-speed lane maintenance on motorways, was agreed upon.As a framework for judging safety that has been discussed in the context of international standards harmonization, the guideline of whether the risk level is below the socially acceptable risk level is a proven criterion for judgment for the social implementation of technological innovations, including those in industries other than the automotive industry, and discussions continue on realizing acceptable risk levels in the field of automated driving. In the Framework Document on Automated Driving[5] adopted in June 2019 after discussions under WP.29, the concept that it is necessary to ensure that no reasonably foreseeable and preventable accidents involving injury caused by automated driving systems occur within the set ODD was set forth. In this discussion, the Ministry of Land, Infrastructure, Transport and Tourism, the National Traffic Safety and Environment Laboratory, and JAMA made proposals under JASIC, one of which was to interpret the "reasonably foreseeable preventable level" as "whether the system performance exceeds a human driver's capability," using a "competent and careful human driver" as a reference for a human driver's capability.[6][7] This was codified in UN-R157 5.2.5, and incorporated into UN157 Annex 4 - Appendix 3 Guidance on Traffic Disturbance Critical Scenarios for ALKS as safety assurance standards for measurable and comprehensive safety assurance scenarios.

2.2. International Cooperation to Support Harmonization of International Standards

As a background to this discussion, a project on safety assurance scenarios was launched as ISO TC22/SC33/WG9 by the convenor of CATARC, China, and the Japanese VMAD chairman expressed his hopes for technical input from the ISO side to the SC33/WG9 convenor. In response to this, JAMA provided support for the promotion of harmonization between international standards and international criteria by proposing the Safety Assurance Guidelines[8] to both ISO and VMAD. Furthermore, the promotion of ISO 34502, which defines a scenario-based safety assurance framework under the international standard SC33/WG9, progressed smoothly through close collaboration between the Japanese leader and German co-leader, leading to the issuing of an international standard in November 2022. This is the fruit of the relationship of trust that has existed between Japan and Germany since the first phase of the Pegasus project, which has continued through close technical cooperation. As described above, UN-R157 reached a certain level of technical maturity after about one year of discussion and led to the world's first international harmonization of standards for Level 3 automated vehicles, which is the result of strategic international collaborative efforts supported by close cooperation among industry, government and academia in Japan. These achievements will serve as the foundation for Japan's continued international contribution to the international standards harmonization discussion in the future. (Fig.7)

2.3. New International Cooperation Efforts

While past collaborations between Germany, France, China, and the U.S. have been aimed at accelerating technological studies through individual projects, going forward it will be necessary to integrate various types of collaboration in order to harmonize the international standards activities that have flooded the automated driving space. As one of the measures to achieve this, the EU and Japan launched a joint initiative to compile a white paper[9] that brings together the state of the art of safety assurance frameworks in cooperation with the European automated driving project HEADSTART,[10] and published the paper in December 2021.

3 Conclusion

While automated driving technology is expected to significantly reduce the number of traffic accidents caused by drivers, and to enable freer and more convenient mobility in society, there are still significant issues to be addressed regarding the sufficiency and transparency of its safety performance. It is important to realize a healthy competitive environment for the realization of a safe transportation society by continuing to build common foundational technologies through collaboration among industry, government, and academia and to develop standards and criteria through international cooperation.

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6) Connected Vehicles

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(Abstract) Participation in SIP-adus workshops and related international conferences in the context of connected and cooperative automated driving technologies not only promoted overseas trend survey but also contributed to outreach activities from SIP- adus and building networks with overseas experts. In particular, the SIP-adus Workshop introduced SIP-adus activities to overseas experts to deepen understanding and about the status of overseas activities from the experts themselves. At international conferences held in Europe and the United States, a wide range of information on government initiatives and business activities in each country has been obtained. This article introduces an overview of these efforts.

Keywords: Cooperative mobility, ITS, V2X, DSRC, C-V2X

1 Outline of Activities

Concerning the connected vehicle, the status in using radio communication technology in Japan was publicized to foreign countries. Several surveys on trends in Europe and the United States were conducted, the results of which were disseminated to related parties in Japan.

2 SIP-adus Workshop

2.1. FY2018 SIP-adus Workshop

1) Plenary Session

The latest pieces of information, outlined below, were explained by experts from the U.S. and Europe on the "connected vehicle":

Kevin Dopart (United States Department of Transportation):

Introduced an overview of Automated Vehicle 3.0 (AV 3.0) by the USDOT. V2X deployment programs including Vehicle Safety Communication Support pilot projects and their field operational tests at 70 sites in the United States were also explained.

John Kenney (TOYOTA IT Center):

Presented on topics related to FCC (Federal Communications Commission) technological requirements, the status of the US market (5,315 roadside units), DSRC (dedicated short range communication), cellular V2X (C-V2X) for 5.9GHz band DSRC, along with WiFi bandwidth.

Christian Rousseau (RENAULT):

Introduced topics such as EU projects, SCOOP, an overview of V2X-related tests in C-ROADS, sharing of 50MHz in 5.9 GHz frequency band allocated in EU (road traffic 30MHz, railroad 20MHz), etc.

Maxime Flament (5G Automotive Association):

Introduced network slicing and edge computing as newest communications technology.

From Japan, the followings were introduced as SIP-adus activities in Japan including the verification of capabilities for applying V2X application through ITS communication, an overview of FOTs (Field Operational Tests) and installation of communications infrastructure in Tokyo Waterfront City area.

2) Breakout Workshop

15 participants (2 from US, 3 from Europe, 10 from Japan) shared trends in each area.

The US speakers introduced issues to study they hold , such as neutrality of technology related to use of 5.9GHz and communications compatibility with each device/state.

The European speakers introduced EU projects HEADSTART, ICT4CART, 5G CROCO, 5G MOBIX, and 5G CARMEN, and gave an overview of Delegated act of V2X.

The Japanese speakers introduced studies of technological requirements related to delivering traffic signal information and expressway merging.

2.2. FY2019 SIP-adus Workshop

1) Plenary Session

Three presenters, including a Japanese speaker, took the podium.

Kevin Dopart (United States Department of Transportation):

Explained details of CARMA (Cooperative Automation Research Mobility Application), a cooperative automated driving development platform.

Kodo Shu (Huawei):

Introduced an overview of the inter-operability test using C-V2X at Wuxi, Jiangsu.

From Japan, the main points of communications utilization plans in the first phase of SIP-adus and plans for the FOTs in the Tokyo waterfront area in the second phase were explained.

2) Breakout Workshop

Ten experts (US:1, CN:2, JP:7) joined in the workshop and shared information related to connected vehicles.

The US expert explained CARMA as described above and introduced SAE J3216 "Taxonomy and Definitions for Terms Related to Cooperative Driving Automation for On-Road Motor Vehicles."

The Chinese experts gave complementary explanations of practical application in buses and commercial cars, which would be preceded than others, among those tested in Wuxi.

The Japanese experts explained initiatives by the National Police Agency and Ministry of Internal Affairs and Communications, SIP FOTs (Field Operational Tests), activities by automobile manufacturers and actitivies in ISO/TC204/WG14 (Intelligent Transport Systems / Vehicle - roadway warning and control systems) as its chair country.

2.3. FY2020 SIP-adus Workshop

In FY2020, the workshop was held online due to the impact of COVID-19, and only the Plenary Session was held.

Kevin Dopart (United States Department of Transportation):

Introduced the categories of cooperative automated driving based on SAE J3216 which was shown at the previous year's session and CARMA as well as truck platooning.

John Kenney (TOYOTA IT Center):

Reallocation of spectrum for ITS by FCC (Federal Communications Commission) and an overview of next-generation DSRC-IEEE802.11bd.

Christian Rousseau (RENAULT):

Introduced the PACV2X and InDID projects for C-ITS in France.

Japanese speakers introduced action plans related to frequency allocation by the Ministry of Internal Affairs and Communications, studies on SPaT (Signal Phase and Timing) information provision through V2I and V2N system, and use cases for cooperative automated driving by SIP-adus.

2.4. FY2021 SIP-adus Workshop

In FY2021, the workshop was also held online due to COVID-19.

1) Plenary Session

The following overseas experts participated in the session.

John Kenney (TOYOTA IT Center)
Tom Schaffnit (USDOT)
Niels Peter Skov Andersen (Car2Car-CC)
Martin Böhm (Austria Tech)

In the US, there is a proposal by the FCC for the spectrum of 5.9GHz bands for ITS to be reduced from current 75MHz to 30MHz, allocating remaining 45MHz to WiFi, in conjunction with transition of the communications channels from DSRC to C-V2X.

An overview of planned and operational projects in each US state were introduced. Approximately 6,000 infrastructures and 18,000 vehicles are in operation in 143 locations. A majority use the DSRC system, but there is some movement to shift to C-V2X.

In Europe, hybrid communication systems, ITS-G5 (DSRC) for short range communication and cellular network for long range, have begun to be introduced in the market in 2019. At least 500,000 vehicles are on roads with the system and infrastructures are also deployed, as 2,000 km of DSRC and 100,000 km of cellular networks.

Two Japanese speakers introduced FOTs using communication networks at the Tokyo waterfront area and status of studies on communication method roadmap discussed through the Task Force (TF) on V2X communication for Cooperative Driving Automation.

2) Breakout Workshop

In addition to the speakers of the Plenary Session, the following experts joined in a panel discussion and Q&A.

Host:
Satoshi Oyama (Association of Radio Industries and Businesses)

Panelists:
Justin McNew (JMC Rota Inc.)
Bettina Erdem (Continental AG)
Shinji Ide (Ministry of Internal Affairs and Communications)
Koichi Sakai (Ministry of Land, Infrastructure, Transport and Tourism)

Despite the fact that the session was held from 11:00 pm JST, there were 134 audiences including 32 overseas participants.

US speakers spoke about development of C-V2X and its standardization and European speakers introduced the status of private-public cooperation for the C-Roads Project.

Japanese speakers introduced status of studies on frequency for ITS by the Ministry of Internal Affairs and Communications, utilization of ETC 2.0 from the Ministry of Land, Infrastructure, Transport and Tourism, the FOTs in the Tokyo waterfront area by SIP-adus, and activities for the TF on V2X communication

for Cooperative Driving Automation.

2.5. FY2022 SIP-adus Workshop

This was the first in-person workshop in three years.

1) Plenary Session

The same four speakers as the FY2021 session provided the new information related to the US and Europe. The Japanese speakers reported the results of SIP-adus FOTs using communication network.

2) Breakout Workshop

In FY2022, as a non-public workshop, experts engaged in a deep discussion on issues to spread connected automated driving.

3 Information Gathering: Participation in international conferences

3.1. ITS America Detroit / CV-Pilot / Smart Columbus (06/2018)

ITS America Annual Meeting:

GM announced introduction of ITS radio in the next generation Cadillac. The USDOT showed its position of technological neutrality related to the conflict between DSRC and C-V2X.

CV (connected vehicle) pilot:

An SIP expert visited traffic control center in New York and investigated the status of connected vehicle pilot programs, such as implementation in roadside units.

Smart Columbus:

The SIP expert observed smart city feasibility tests in Columbus, Ohio. Planning was proceeding to combine public transportation and personal traffic.

3.2. Automated Vehicle Symposium in San Francisco (7.9-12, 2018)

U.S.:

Promotion groups for DSRC and C-V2X emphasized the benefits in terms of technology and operation of their communications method.

FHWA (Federal Highway Administration) placed roadside units in 15 intersections in Texas and 13 intersections in Michigan. Trials to optimize traffic flow by green light optimal speed advisory and priority of CACC (Cooperative Adaptive Cruise Control).

Europe:

The EU Project ICT4CART aims for level 4 automated driving by using C-ITS and C-V2X. Test sites in Austria, Germany, and Italian and cross-border Italy-Austria courses are to be employed to verify interconnectivity.

3.3. ITS World Conference Copenhagen (9/17-21, 2018)

The overview, certification method, and privacy issues with regard to the Delegated Act related to V2X proposed by the European Commission were reported.

In the US, CV pilot deployment programs began. Challenges in the system implementation were explained, including vehicle localization accuracy in downtown New York and data collection issues. It was also reported that the number of DSRC roadside units, the purpose of which is still testing, has exceeded 5,000 in the U.S.

3.4. Transportation Research Board, Washington D.C. (1/13-17, 2019)

The USDOT introduced the CARMA platform and its application development.

AUTOCITS (2016-2019) was introduced from Europe.

In order to improve safety and to apply C-ITS to automated driving, Verification tests were being conducted on roads that crossed from Portugal to Spain (10km expressway) and France.

The 5GCroCo, 5G-Carmen, and 5G-MOBIX started as 5G-related projects. The cross-border projects were being conducted over 1,000km of road across eight countries.

The European Commission passed the C-ITS Delegated Act and planned to finalize after inviting public comments.

3.5. Automated driving symposium Orlando, Florida (7/15-18, 2019)

FHWA director declared that he would protect the 5.9GHz for traffic safety in response to the FFC director's comments about reallocation of frequencies, including releasing some 5.9GHz bands to WiFi.

3.6. ITS World Congress Singapore (10/21-25, 2019)

In Europe, the C-ITS Delegated Act was rejected by the European Parliament. The C-ITS deployment had, therefore, become dependent on initiatives in the private sector.

In the United States, 5GAA requested allocation of upper 20 MHz in 5.9GHz bands (75MHz) to cellular V2X.

3.7. Transport Research Board Washington D.C. (1/12-16, 2020)

In the CV-Pilot session, in addition to progress reports in three zones (New York, Tampa and Wyoming), there were some negative opinions about equipment renovation expenses and project delays related to repurposing 5.9GHz bands by the FCC.

3.8. Automated driving symposium Garden Grove, California (7/19-21, 2022)

This symposium was held in person for the first time in three years. Because accidents of pedestrians looking at their smartphones is increasing in the US, there is increased attention on "Cooperative Perception" by FWHA (Federal Highway Administration), the recognition of objects outside of view by sharing onboard/roadside sensor data using pedestrian/cyclist protection technology and communications through V2X.

Also, in Europe, the roadmap of the CCAM (Connected, Cooperative & Automated Mobility) Partnership, which close to 200 organizations participate in, was presented. Large scale tests are planned at 30 places across Europe in 2030 and it can be seen that full-scale implementation is envisioned after 2030.

In addition to the above, information gathering is planned in FY2022 at the ITS World Congress 2022 Los Angeles (September 2022), Transportation Research Arena 2022 Lisbon (November 2022) and Transportation Research Board Washington DC (January 2023).

4 Information transmission

The following is information transmission besides the SIP-adus Workshop.

4.1. World Forum for Harmonization of Vehicle Regulations (WP.29 ITS IWG) held online (11/6, 2020)

There were chances to introduce SIP-adus activities at WP.29 ITS informal groups, including the status of deliberations of use cases for Cooperative Driving Automation and activities for SIP-adus Task Force (TF) on V2X communication for Cooperative Driving Automation.

4.2. Future Network Car Web held (3/25, 2021)

Requested from the WP.29 participants above, an SIP expert participated in a conference hosted by ITU (International Telecommunication Union) along with approximately 150 participants. The status of studies and the use cases related to SIP-adus cooperative automated driving communication methods were presented.

5 Conclusion

Direct exchange with overseas experts through international cooperation activities contributed to the improvement of mutual understanding and awareness of the status of activities in Japan, the US, and Europe.

The International Cooperation Working Group activities end this year. However, the knowledge built in these five years will be a precious asset to Japan's activities related to automated driving in years to come.

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7) Cybersecurity

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(Abstract) We can assume that the advanced map information that forms the basis of automated driving systems and the information on vehicles, people, infrastructure facilities, etc. that are mapped on those maps, will be obtained mainly from external networks.

This information is sent to the control/information devices of the vehicle for use in vehicle control by the automated driving system, but this also causes cybersecurity problems that have not existed in conventional vehicles. In addition, with the agreement of UN-R155/R156 at UNECE[1] WP.29, it is necessary to take measures against cyberattacks from the legal point of view as well.

In order to solve such problems, the second phase of SIP-adus (Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services) focused on intrusion detecting systems (IDS) as a countermeasure technology against cyberattacks post-shipment. The evaluation viewpoints and testing methods for selecting IDS were studied for off-the-shelf development that utilizes existing products, and verification using whole vehicle test bench was conducted and summarized as IDS evaluation guidelines.

In addition, to speed up the initial response to new threats when they emerge, we are studying a mechanism for quickly providing threat information on connected cars and a method for proactively collecting potential threat information. We are analyzing threat intelligence activities in the leading IT industry to establish a mechanism and verify its feasibility, as well as examining honeypots and conducting observation experiments to verify their effectiveness. Furthermore, through a Japanese-German cooperative workshop, experts from Japanese and German universities have joined to share and utilize their knowledge on these efforts.

Keywords: cybersecurity, IDS (Intrusion Detection Systems), threat information, honeypots, playgrounds

1 International Legal Trends

The World Forum for the Harmonization of Vehicle Regulations (WP.29) has established international standards for automated driving, namely UN-R155 (cybersecurity) and UN-R156 (software updates). Japan, as a co-chair of WP.29 GRVA, has been promoting cybersecurity, and has been ahead of other countries in enacting legislation, especially for Level 3 automated vehicles.

In line with this, automakers must comply with process certification under UN-R155 for all new passenger and commercial vehicles released to the market after July 2022 in order to obtain type certification (continued production vehicles must be compliant from July 2024 onwards). UN-R155 requires having a cybersecurity management system and processes that adequately respond to new and evolving cyber threats and vulnerabilities, and these processes are subject to triennial audits.

OEMs and suppliers are building on the aforementioned process with reference to the international standard ISO/SAE 21434, which was officially issued on August 31, 2021 and is referenced as an example of meeting the requirements of UN-R155.

Based on this background, in this project we conducted researches on detection technologies for cyberattacks emerging especially after vehicle production and on collection and sharing system of cyber threats such as vulnerability, with the aim of transferring and utilizing the results in industry organizations.

1 UNECE: United Nations Economic Commission for Europe

2 Current Issues and Research Status

2.1. Development of IDS Evaluation Guidelines

From a legal standpoint, WP.29 UN-R155 requires that cyberattacks be detected and handled appropriately, and it is necessary to explain that the vehicle itself is capable of detecting and handling cyberattacks. However, existing regulations and guidelines do not clearly indicate what kind of attacks should be detected and to what extent, so it is necessary for each company to make its own determinations. With this research theme, we aim to contribute to post-shipment security measures, with the goal of developing IDS Evaluation Guidelines and transferring the results to industry organizations so that OEMs can use them as a baseline when selecting, verifying, and operating on-board IDS.

The guidelines are meant to improve the quality of post-shipment vehicle cybersecurity throughout the industry, and are especially intended for OEMs that have just begun considering the introduction of on-board IDS.

In these activities, we derive cybersecurity events that IDS should detect based on actual attack cases. In order to derive this information, we conducted a survey of conferences held and vulnerability information released from 2017 to 2020.

From these results, among cases that directly related to vehicles, we further narrowed down the cases that affected vehicle control and analyzed them in detail to extract events that could be generated and observed in the network as cybersecurity events. (Table 1)

With this research theme, based on the results of previous research, from known specific attack cases we developed a method for creating scenarios of attack cases and a method for deriving functional requirements to detect similar attacks. We also derived test items for these functional requirements for detection, verified the feasibility and validity of the test items through experiments on actual benches with the cooperation of OEMs and IDS vendors, and implemented feedback to the guidelines from these basic test cases.

Table 1: Cybersecurity events extracted from the survey cases

Events	Overview
Invalid message ID	Message ID does not exist on (bus)
Data range error	Invalid range of signal values for a single message
Invalid transmission cycle	Invalid transmission cycle for messages with the same message ID
Invalid message volume	More/fewer messages on on-board NW than specified
Invalid transmission order	Invalid reception sequence for multiple messages
Amount of change in invalid data	Invalid difference from the data value of the message received immediately before
Context violation data	Invalid correlation of data values for multiple messages
Invalid source/destination	Invalid message source (determined by CAN using ECU feature volumes, MAC, etc.) Message destination is invalid (for TCP/IP)
UDS Protocol violation	Violation of UDS protocol specifications
OBD protocol violation	Violation of OBD protocol specifications
DoCAN protocol violation	Violation of DoCAN protocol specifications
Error response of diagnostic msg in excess of the specified number of times	Receipt of error responses for diagnostic messages in excess of the specified number of times

In addition, in the interests of social implementation, discussions were held at regular study meetings with the stakeholders to ensure that the system is useful for the intended users, and the results were built upon.

The results of these investigations and experiments have been compiled into a single achievement, namely the "IDS Evaluation Guidelines," and the results therein have been transferred to industry organizations.

2.2. Investigative Research on Threat Information and Initial Response Support for Connected Cars

We have developed a method for collecting and storing threat information on connected cars as well as a basic system specification for initial response support using threat intelligence, and are working toward the goal of transferring these to industry organizations for operations in 2023.

Threat intelligence is information collected, analyzed, and accumulated to support responses to cyberattacks and other threats. In some industries, cross-company intelligence sharing activities are underway.(1)

By sharing threat intelligence, companies can expect to prevent successive damage from similar cyberattacks, but the threat intelligence that is currently shared is mainly from the IT domain. In IT systems, a common platform may be used among organizations and users, such as a general-purpose OS, while in automobiles, each vehicle model has a different architecture. Therefore, there is a risk that the form of threat intelligence that is shared in the IT domain cannot be used for countermeasures. This is because automobiles are OEM-dependent in terms of hardware, software, and communication protocols for vehicle control, which is a major difference from IT.

On the other hand, the sequence of attacks leading up to vehicle control may use OEM-independent methods, and as a common threat among OEMs, we can expect that this information is worth sharing.

In addition, the key to responding to new threats that emerge after shipment is not only the sharing of threat information, but also the ability to proactively ascertain threat information to speed up initial response.

Honeypots are one such proactive threat information collection method. For example, as an observation result of current threat information collection experiments using honeypots, we observed activity that matches the characteristics of IoT malware (e.g., Mirai), which sends IDs and weak passwords to telnet as it would to IoT products. (Fig.1) This is considered to be an automated attack from a device infected with the malware, and not an attack based on the recognition of the honeypot as an on-board device.

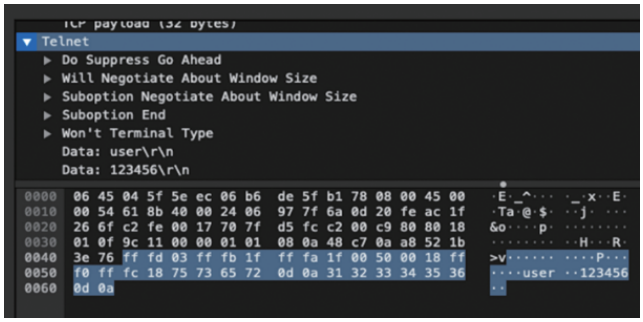

Fig.1: Example of observed packets

Our current research theme is part of a plan that extends to February 2023. As of September 2022, we are conducting experiments to collect threat information and studying methods to share the collected information for use in incident response within the industry. In the future, we plan to utilize description methods for threat information, build mechanisms for systems to share the assumed threat information, and verify their feasibility through proof of concept.

For proactive information collection, we plan to set up honeypots and conduct experiments to observe threat information, as well as hold playgrounds where white hat hackers, vendors, and others can try out attacks, and observe the activity during these events.

3 Japanese-German Cooperation

In Germany, the Federal Ministry of Education and Research (BMBF) is leading an initiative to support research and development of security for the connected and automated car, and four projects are currently underway. Of these, we are collaborating with the SecForCARs project,[(2)] which entails four research topics (#1: Hardware and on-board network cybersecurity, including ECUs and their constituent LSIs; #2: Requirements and verification methods for the overall security of a vehicle system consisting of secure subsystems; #3: Methodologies for observing, capturing, and analyzing cyberattacks; and #4: Methods for using actual vehicles and virtual systems [honeypots] for assumed attack vectors to observe cyberattacks). The project has participation by experts from Japanese and German universities to share and utilize their knowledge from both sides. The research status and results are being shared through workshops (five workshops are planned by the end of 2022, the first in July 2021, the second in December 2021, and the third in April 2022.)

4 Conclusion

It is no exaggeration to say that ensuring automotive cybersecurity is directly linked to the safety and security of automobiles, and it is appropriate to make the minimum security standards to be met and common threats in the industry a cooperative area for the entire industry, and to actively share them. This will also improve the efficiency of the development and operation of connected services and help Japanese companies maintain their international competitiveness.

It is also important to strategically approach standardization organizations so that security measures and information sharing mechanisms can be used to the advantage of Japanese companies by, for example, proposing them as international standards for automotive cybersecurity development, rather than limiting them to sharing within the domestic industry.

Cybersecurity is essential for automated driving systems, including connected cars, which are still in the development stage. Cybersecurity threats to them are expected to increase in the future. Going forward, it is important to continuously evaluate and improve cybersecurity as social implementation progresses and actual threats become more apparent.

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8) Socioeconomic Impacts

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(Abstract) International cooperation efforts on socio-economic impact have been promoted mainly within the framework of Japanese-German cooperation. Specifically, the German research project CADIA, led by researchers from the German Aerospace Center (DLR) and Karlsruhe Institute of Technology (KIT), and the two projects commissioned to the University of Tokyo and Doshisha University under the second phase of SIP-adus (Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services): "Study of socioeconomic impacts of automated driving including traffic accident reduction" and "Development of assessment methodology for socioeconomic impacts of automated driving including traffic accident reduction." This collaboration was recognized by the Japanese-German Steering Committee for Bilateral Cooperation in January 2019. Frequent online meetings are held between the two countries, with experts from both sides also meeting in person in Germany in October 2019 and Japan in May 2022 to discuss such issues as the diffusion models for automated driving and public acceptance of new transportation services by automated driving, in light of shared international understanding and national and cultural differences. The results will be published in early 2023 as a book jointly authored by Japan and Germany. In addition, during the annual SIP-adus Workshop and the Trilateral Conference among Japan, the U. S., and Europe, there was an exchange of information and opinions on socio-economic impact not only between Germany and Japan, but also among a wide range of international stakeholders.

Keywords: automated driving diffusion model, public acceptance, international shared understanding, national and cultural differences, international joint publication

1 Background and outline of activities

Regarding the collaboration between Japan and Germany on automated driving, activities were carried out based on "Joint Declaration of Intent on Japanese-German Cooperation on the Promotion of Research and Development on Automated Driving Technologies" between the Cabinet Office and the German Federal Ministry of Education and Research (BMBF) on January 12, 2017.

Japanese and German sides exchanged opinions on the R&D themes that should be promoted in cooperation. In regard to the social impact assessment, the Japanese second phase of SIP-adus conducted the "Study of socioeconomic impacts of automated driving including traffic accident reduction" and "Development of assessment methodology for socioeconomic impacts of automated driving including traffic accident reduction," while in Germany a consortium led by the German Aerospace Center (DLR) adopted similar research as a BMBF-supported project and began collaborative activities in the 2019 fiscal year. From the Japanese side, the research project members led by Professor Ayako Taniguchi of the University of Tsukuba also volunteered to cooperate. The final product is scheduled for publication in early 2023 as a joint publication.

Meanwhile, in the ITS trilateral meetings among Japan, the U.S., and Europe, impact assessment (IA) has been set as a sub-theme for the trilateral collaboration, alongside digital maps and human factors, with the aim of realizing a high level frame for evaluating the impact of automated driving on the overall transportation society in a mutually harmonized manner in the three regions. Provision and sharing of information and debate are ongoing in order to achieve these ends.

Here, we introduce these two instances of international cooperation relating to socioeconomic impact.

2 Undertakings in Japanese-German cooperation

2.1. Project formation background

Regarding the Japanese-German cooperation on the social

impact of automated driving, first, the research members of the SIP-adus "Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others" visited the Institute for Technology Assessment and Systems Analysis (ITAS) of the Karlsruhe Institute of Technology (KIT) in the fall of 2018 to exchange views on the possibility of a Japanese-German cooperation. Subsequently, in FY2019, experts from both countries held discussions and agreed that the following two points are of merit and interest to both sides as matters for collaboration in both countries.

1) Diffusion of Connected and Automated Driving in a Future Vehicle Stock: The aim of this theme would be to construct a model to quantitatively simulate the spread of automated driving by identifying the factors that affect this spread and analyzing their correlation. Through this initiative, feasible popularization scenarios for the next several decades could be drawn up.
2) Social Acceptance of Automated Driving Explored: In addition to defining what is meant by social or public acceptance of automated driving, the aim of this theme would be to carry out an advanced research and study program to analyze cross-border similarities and differences attributable to separate social and cultural environments with respect to public acceptance of automated driving. In addition, this program would also identify discussion points related to national innovation strategies related to automated driving, as well as issues for international cooperation related to automated driving and its related technologies (including standardization).

In January 2019, BMBF in Germany and SIP-adus in Japan convened a meeting of the dual Japan-Germany Collaborative Program Steering Committee, and decided to launch a joint Japan-Germany research program that combined these two themes into a single project. It was also agreed to set outcomes of the collaboration as holding joint-symposium to deliver the fruits of the collaboration and a publishing book jointly, after having regular research meetings.

2.2. Summary of progress in Japanese-German co-operative research

In the 2019 fiscal year, after a series of online advance preparation meetings, Japanese experts visited Germany on October 7 and 8, and held the first meeting of the joint project at the Berlin office of the DLR.

The main objective of the first meeting was to outline the projects being carried out by both sides, to describe the points of interest of each country, and to determine the direction of the collaborative project. After discussion through the meeting, the discussion point for the next meeting was determined to be the issues on car ownership and sharing. The second meeting was scheduled to be held in March 2020 in Japan, but due to the worldwide COVID-19 pandemic, the schedule was drastically changed, and it was decided to promote collaborative activities mainly through online meetings.

At the 4th bilateral expert workshop for the Japanese-German research cooperation, held on November 25, 2020, and the 5th bilateral expert workshop for the Japanese-German research cooperation, held on December 6, 2021, Japanese and German experts on social impact assessment gathered online to report on the progress of their activities to the German BMBF, the Japanese Cabinet Office, and the SIP-adus program director (PD).

We have been holding frequent online meetings since April 2021 to discuss the policy, content, and structure of the publication of a book as a result of our joint efforts. During the first half of 2022, we worked on actually writing the book. The second meeting was held in May 2022 in Kyoto, Japan, during a break in the COVID-19 pandemic. The content of the manuscripts prepared by both Japan and Germany was mutually confirmed, and then reconciled and adjusted, with a session held with reference to this discussion in order to deepen a shared understanding of points of commonalty and difference between the two countries. Based on the discussions in this session, we decided to draft the final section of the manuscript for joint publication, and from July onward, we worked together to prepare the manuscript for publication in early 2023 through mutual readings and peer review and proofreading by external parties.

2.3. Activities in the SIP-adus Workshop

As part of the SIP-adus Workshop 2020 held on November 10-12, 2020, an online symposium was held on November 9 with experts in Japanese-German cooperation activities on impact assessment. The content on this topic was widely disseminated by distributing a recording of the symposium. Speakers were Torsten Fleischer (Karlsruhe Institute of Technology), Ayako Taniguchi (University of Tsukuba), Satoshi Nakao (Kyoto University), Kosuke Tanaka (Tokyo University of Science), Hiroaki Miyoshi, Shoji Watanabe (Doshisha University), Masanobu Kii (Kagawa University), Christine Eisenmann (German Aerospace Center), and Bart van Arem (Delft University of Technology).

Although the session was held online, it was an excellent opportunity to hear four reports, and online discussions continued voluntarily after the session ended. Opinions were exchanged actively about the following discussion points: the diffusion of automated vehicles, predictions of remaining human-driven vehicles, the public acceptance of transportation services using automated driving and their impact on daily behaviors and habits, the difficulty of securing lanes exclusively for automated driving vehicles, and other topics.

On November 9-10, 2021, the Plenary Session of the SIP-adus Workshop 2021 was fully recorded and broadcasted. In

the session with the theme of "Impact Assessment," Christian Winkler (German Aerospace Center), Hiroaki Miyoshi, Shoji Watanabe (Doshisha University), Masanobu Kii (Kagawa University), Torsten Fleischer (Karlsruhe Institute of Technology), Ayako Taniguchi, Kasumi Miyadai (University of Tsukuba), and Scott Smith (Volpe Center, US Department of Transportation) gave presentations. A hybrid-style Breakout Workshop was also held in person onsite and online, and in addition to the plenary speakers, Bart van Arem (Delft University of Technology) and people involved in the Japanese-German cooperation project participated in a 3-hour session for information exchange and discussion on automated driving diffusion models and their social impact.

2.4. Joint publication by Japan and Germany

The contents of the book entitled "Japanese-German research cooperation on connected and automated driving: Socio-economic impact assessment" was started to be discussed from 2021 and written by the members of the Japanese-German cooperation in the first half of 2022. The book is composed as follows:

1. Introduction
2. Characteristics and trends of the Japanese and German mobility systems
3. Policy process with respect to CAD in Japan
4. Industry analyses and prognoses regarding CAD ride-hailing market
5. Detailed evaluations of the empirical material on acceptance of CAD
6. Transportation effects of CAD in Germany
7. Transportation effects of CAD in Japan
8. Overall Comparison between Germany and Japan

The discussions at the session held in May 2022 are organized and described in section eight of this book. More specifically, the following nine points are discussed: Social expectations affecting CAD diffusion; common expectations of groups and individuals in Germany and Japan; attitude of the car industry; mobility services expected to be realized; differences in forms of residence; decision-making toward diffusion; expectations for the type of CAD initially introduced; forming a correct understanding of CAD by citizens; and risks that may affect expectations.

3 Trilateral cooperation among Japan, the U.S., and Europe

Regular trilateral meetings among Japan, the U.S., and Europe have been held to exchange information and opinions related to general ITS topics, including automated driving. Under the scheme of this trilateral meeting, a sub-group related to Impact Assessment of automated vehicles is organized. This sub-group is run by the following representatives: Dr. Scott Smith from the Volpe National Transportation Systems Center run by the United States Department of Transportation (DOT) for the U.S., Dr. Satu Innamaa from the VTT Technical Research Centre of Finland for Europe, and, currently, Takashi Oguchi from the University of Tokyo (the author of this paper) for Japan. This sub-group meets two or three times a year to exchange information about initiatives being carried out in each region, and the free exchange of opinions has continued throughout. In Europe, research activities funded by the Horizon 2020 and various other government supported projects in each country are underway, which form the background of the research reported in these meetings. In contrast, the Volpe Center in the U.S. is currently building a system dynamics model for establishing the framework of the Impact Assessment. These progresses are reported at the meetings. Japan has also been reporting as appropriate on the activities in our "Study of socioeconomic impacts of automated driving including traffic accident reduction" and "Research on assessment of the impact of automated driving on society and the economy and on measures to promote deployment."

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9) Service and Business Implementation

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(Abstract) Discussions on the social implementation of services which utilize automated driving are important for the commercialization of automated driving.Although pilot programs of services which utilize automated driving have been conducted in Japan and overseas, the issues that arise when stepping up from tests to implementation and measures to deal with them are still the subject of various studies and discussions around the world.Therefore, in our international cooperation activities, we have been exchanging information on the implementation of automated driving in other countries from the perspective of promoting service and business implementation.This paper introduces the status of these efforts.

Keywords: social implementation, business model, service and business implementation, service cars, mobility service

1 Introduction

The implementation of service vehicles (Note: in this paper, 'service vehicles' refers to vehicles used for passenger and logistics transportation services, as opposed to private vehicles) that utilize automated driving has been promoted since the first phase of SIP-adus (Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services) under the activities of the Next Generation Transport Working Group, and also in international cooperation as "Next Generation Transport" under the leadership of (then) Professor Masayuki Kawamoto of Tsukuba University.

In the second phase of SIP-adus, with a greater awareness of the perspective of implementation, the Next Generation Transport Working Group became the Service and Business Implementation Working Group, and in international cooperation activities as well, activities were conducted under the new area name of "Service and Business Implementation" (SBI) from the 2020 SIP-adus Workshop. In international cooperation activities, the topic of FOTs (Field Operational Tests) was also worked in cooperation with SBI.

2 Activities in the SIP-adus Workshop

Although the study use cases and business models of services which utilize automated driving is important for the commercialization of automated driving, the issues that arise when stepping up from FOTs to implementation and measures to deal with them are still being discussed both in Japan and overseas. Therefore, SBI conducted discussions on service and business implementation with domestic and foreign experts through workshops.

2.1. FY2021 SIP-adus Workshop

At the FY2021 SIP-adus Workshop,[1] the Plenary Session was held as a joint session with Human Factors.With the commercialization of automated driving approaching, there are many areas which are related to human factors, so we jointly planned sessions, selected participants, and set the presentation topics to enable integrated discussions on how to connect "technology" with "urban activities and people," how to design services, and how to think about business models.

Because it is essential to consider human factors, service design, and business models for the social implementation of automated driving, the session was planned to focus not on the technology itself but on the areas that connect the technology

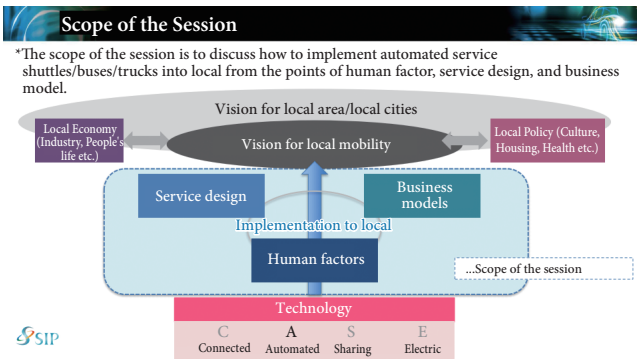

Fig.1: Agenda for the 2021 Plenary Session

and local cities/areas as the scope, as shown in Fig.1.

The Plenary Session was jointly organized with Human Factors and a total of eight speakers were invited. Experts in a wide range of fields from the U.S. and Europe appeared, including some who were invited to the SIP-adus Workshop for the first time in FY2021.

The speakers presented on the technological development and FOTs of automated driving in various regions and cities around the world, and provided topics that focused on discussions on implementation from the initiatives in their respective countries. SIP-adus is also aware of "social implementation" in its initiatives, and in order to lead to the introduction of services in real areas, discussions were held regarding what automated driving services should be introduced, based on the viewpoint of which business models and service design and taking into account the vision of each region and city.

Also, a Breakout Workshop was conducted in an online format at a later date. In the Breakout Workshop, the following points were discussed with the speakers from the Plenary Session who were invited from the SBI area.

- What are the benefits of automated driving (from the respective perspectives of citizens, operators, and local government)
- Ideas for the realization of economically self-sustainable automated driving services
- How should local areas accept and manage automated driving (both in terms of policy and service design)

As it was conducted online and included several first-time invitees to the SIP-adus Workshop, it was a difficult environment for cross-discussions among the speakers, but it was an opportunity for the Plenary Session speakers to meet each other and mutually exchange opinions and answer questions.

2.2. FY2022 SIP-adus Workshop

The FY2022 SIP-adus Workshop,[2] which was held in person for the first time in three years, was conducted solely by SBI.

Since this was the last SIP-adus workshop, in addition to an SIP-adus topic on the testing of automated driving services in rural areas as a case study of service and business implementation, three speakers were invited from the U.S. and one speaker from Europe.

In order to implement automated driving services, there are various issues in non-technical areas, such as service design, cooperation with government, and compliance with legal systems. These issues were discussed based on the status of initiatives in the U.S. and Europe.

In addition, the Breakout Workshop was also held in person in FY2022. In addition to the Plenary Session speakers,

3 Information Gathering at International Conferences

3.1. ITS European Congress 2022

(1) Overview of the Congress

The event was held in Toulouse, France from Monday, May 30th to Wednesday, June 1st 2022. AIRBUS and EasyMile have operations in Toulouse.

The theme was "Smart and Sustainable Mobility for all," and as all of the discussions throughout the conference started from an awareness of environmental issues, the author strongly felt the interest in and sense of urgency about climate change in Europe.

The author attended the Plenary Session and individual sessions such as the Special Interest Session (SIS), and the keywords that were often seen and heard during the three days were 'Sustainable', 'Multimodal', 'Digitalization' ('Data'), 'Connected', 'Acceptance', and 'Ecosystem'. The author's interpretation, in the context of these keywords combined with the overall theme, is that the aim is to break away from excessive dependence on private cars as a countermeasure against climate change ('Sustainable'), and a 'Multimodal' response is necessary to achieve this because the alternative means of transportation need to be convenient; to realize this, the 'Digitalization' and 'Connection' of 'Data' is important, and furthermore, the 'Acceptance' of this approach by citizens is necessary; it is also necessary to consider the transportation modes or city as an 'Ecosystem'.

(2) Summary of the Plenary Session Discussion on Service and Business Implementation

At the ITS European Congress, information was collected mainly from sessions that discussed the use of "automated driving" for service uses (i.e. not for private use) such as public transportation. The following is a summary of the main points discussed in the Plenary Session and other sessions.

1) Sustainability

As the theme of the ITS European Congress suggests, of all the social issues in Europe today, sustainability receives the most interest. In the Plenary Session, a speech by a representative of the European Parliament declared that digitalization and sustainability must be proceeded urgently and the mobility sector must also provide smarter solutions.

2) Utilization of urban space

The conference also discussed the utilization of urban space. For example, based on the experiences under the COVID-19 pandemic over the past several years, how people maintain distance from each other, as well as their opportunities to use and stance towards public transportation have changed significantly. Also, new personal mobility devices such as e-scooters have recently appeared and how to adapt them to

urban spaces is an issue. In addition, discussions have begun in Europe regarding the use of urban air space with an eye toward the commercialization of drones and other flying mobility services.

3) Mobility as a Service (MaaS)

MaaS, which is a cross between ITS and digitalization, expands the possibilities of multimodal services and is also highly anticipated in Europe. The Plenary Session discussed how multimodality is indispensable for sustainability and is the only way to achieve it. Harmonization and collaboration were mentioned as keywords for the development of MaaS, and in addition, the transparency of the framework and accessibility that considers all people, including women and people with disabilities, were also mentioned.

3.2. ARTS (Automated Road Transportation Symposium) 2022

(1) Overview of the Symposium

ARTS2022 was held from July 18 to 21, 2022, in Garden Grove, California, U.S.A. The overall size of the conference was reduced from the previous conference held as the Automated Vehicles Symposium (AVS) three years ago. Specifically, the number of sessions was reduced, each session was made longer (with an emphasis on interactive discussion), and demonstrations and the poster space were eliminated.

(2) Summary of the Discussion on Service and Business Implementation

The theme of the ITS Europe Congress was "Sustainable," and most of the discussions started with an awareness of the issue of the environmental impact of mobility, and there was active discussion on using multimodal in order to reduce the environmental impact, reducing the dependence on private car use, and promoting the use of data to make these possible. On the other hand, at this year's ARTS held in the U.S., the sense of crisis over environmental issues was not so much in the foreground, and it was symbolic that discussions on automated driving were conducted from the aspect of other social issues that the U.S. is facing, such as the increase in the number of traffic deaths, international competitiveness, and addressing equity.

Future investment and policy making in the transportation sector based on the Infrastructure Investment and Jobs Act (IIJA) enacted by the Biden administration were also mentioned in various discussions.

In the U.S., various tests of automated driving services are being conducted.

Accessibility has also become an important perspective during development, as the USDOT Federal Transit Authority emphasizes accessibility and has declared the application of the American Disabilities Act to automated driving services, and local government initiatives have also included wheelchair-accessible boarding and alighting technologies (lifts and ramps).

4 Conclusion

As the movement toward the social implementation of automated driving accelerates, as a hint for service and business implementation and business models, it is necessary not only to focus on automated driving technology and automated driving services alone, but also to clarify the social issues that require automated driving services, such as sustainability and traffic safety, as well as the needs related to the necessity of automated driving, and each region demands the creation of models that are aware of the linkage with other mobility services and various policies (environment, welfare, and other urban planning) within the city.

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