Overview of International Cooperation Activities by SIP-adus

Hajime Amano (ITS Japan)

1 Background

In the past ten years, technologies for automated driving have been dramatically improved not only by established automobile manufacturers, but also by startups in the information service industry. The time between the start of research and development of technologies to their deployment as commercial services is being shortened. A variety of activities have been initiated in vehicle technologies, infrastructure, standardization, regulatory issues and field operation tests in every part of the world, even though automobile manufacturers are operating in a global single market. Therefore, international cooperation from the very early stage of development is recognized as an essential aspect of connected and automated driving projects for the international harmonization of standards and regulatory frameworks.

2 Definition of the Goal of the Project

At the beginning of the project, its goal was defined for sharing with international stakeholders. The idea is described as follows.

"An inclusive society, where different people in diverse communities actively participate in generating values, will enhance both the wellness of individuals and economic development. Automated driving technologies integrated with social innovations should provide everyone with mobility to fully exercise their capabilities, enabling the sustainable development of the society."

Then the project was named SIP-adus: Cross-Ministerial Strategic Innovation Promotion program, Innovation of Automated Driving for Universal Services – Mobility Bringing Everyone a Smile –.

3 Focus Areas

The key international cooperation platform for connected and automated driving systems has been the EU-US-Japan Automated Road Vehicle Working Group, co-chaired by the European Commission, U.S. Department of Transportation and the Japanese Ministry of Land Infrastructure, Transport and Tourism. Through discussion with international counterparts, six important areas of international cooperation were identified and six leaders were assigned to coordinate that cooperation. As the project had made progress toward deployment, field operational tests were added as another area of cooperation. All international activities are aligned to those thematic areas.

3.1. Dynamic Map

Digital map databases with a layered structure built on graph network representation of roads will be expanded to include highly detailed description of the road structure and its surrounding environment. The database will be dynamically linked to real-time data from an integrated sensing system onboard the vehicle and semi-real-time data from V-to-X communications. Such databases can only be developed and maintained through collaboration across the industry sectors and public agencies.

3.2. Connected Vehicles

Higher 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. Physically shielded vehicles will notify each other through V-to-V communication. Beyond the horizon of sensing systems, V-to-I communication will provide automated vehicles with additional information.

3.3. Human Factors

The shift between levels of automation will depend on the driving environment and 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.

3.4. Cybersecurity

A connected car is a car that has become capable of providing various services, which enhance its convenience and safety, utilizing DSRC and cellular communication. Also, it uses onboard communication networks such as CAN, LIN, and Ethernet. At the same time, however, there is a risk of exposure to cyberattacks. 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.

3.5. Impact Assessment

Enhanced safety is the objective with the highest priority in vehicle automation. However, automated vehicle technology is only one part of measures to avoid traffic accidents. Field research on vehicle crashes, the modeling vehicle behavior, and the evaluation of a variety of measures are the foundations to take an integrated approach that makes the most effective use of new technologies.

Socioeconomic impacts are also important aspects of the assessment, which will provide a foundation for fostering social acceptance of connected and automated vehicle deployment

3.6. Next-Generation Transportation Systems

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 transit 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 vehicles with enhanced driver assistance for personal use are also anticipated to provide aged or handicapped users with a level of mobility that will encourage them to actively engage in social activities.

4 Major International Cooperation Activities

4.1. Networking

The members of SIP-adus have actively participated in international conferences to share ideas and experiences. Those opportunities include the Automated Vehicle Symposium hosted by the Transportation Research Board and Association of Unmanned Vehicle System International, and the European Conference on Connected and Automated Driving hosted by the European Commission.

4.2. SIP-adus Workshop on Connected and Automated Driving Systems

Annual workshops have been organized for in-depth discussion among international experts. The Workshop is composed of plenary sessions with a series of presentations open to the public, and closed workshops for in-depth discussion with invited experts. Each plenary session is paired with a workshop for a focus area of international cooperation. Presentations and poster sessions on SIP-adus subprojects were organized. Trial rides of prototypes and commercial models with connected and/or automated driving technologies were provided for international participants.

4.3. Internationally Open Platform of Field Operation Tests with Shared Resources Provided

Large scale field operation tests on public roads started in 2017, and are open to any party meeting the minimum qualifications to participate. Test facilities and operation management are provided. Dynamic map data for the test sites and equipment for connected services are provided at no charge. The only requirement for the participants is to actually use those shared resources, submit evaluation reports, and engage in review discussion to improve and accelerate standardization. Participants who test their vehicles have to arrange all other resources by themselves.

4.4. Standardization

Results from SIP-adus, namely human factors, dynamic map and vehicle control systems, have been reflected in international standardization activities at ISO TC22 Road Vehicles and TC204 Intelligent Transport Systems. In addition, collaboration with industry standardization bodies has expanded.

5 Conclusion

SIP-adus has been actively engaged in international cooperation, gained recognition, and developed a network among global experts. This is quite a unique achievement for the Japanese community, which generally has a reputation for being closed.

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Dynamic Maps

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ABSTRACT: The international harmonization of dynamic maps was pursued based on the results of SIP-adus research activities within Japan. The main task of the activities was to broaden the result of R&D to professionals outside Japan and to get feedback for the direction of the further research. The international harmonization activities include fostering international understanding of dynamic maps, arrangement of static map features arrangement, the promotion on SIP-adus FOTs, and moving standardization activities forward. The relationship with related activities in other countries is just at the beginning stage. Continuous action will be needed to achieve international harmonization of dynamic maps.

1 Basic Approach

The international harmonization of dynamic maps was pursued based on the results of SIP-adus research activities within Japan. The main task of the activities was to broaden the result of R&D to professionals outside Japan and to get feedback for the direction of the further research. The activity started at the beginning of the SIP program in 2013.

The main actions included:

- Making presentations at international conferences, including the ITS world congress, the Transportation Research Board (TRB) annual meeting, the Transport Research Arena (TRA), the Autonomous Vehicles Symposium (AVS) and other related events within and outside Japan.
- Organizing SIP-adus workshops (dynamic map session) in Tokyo.
- Discussing the topic at the EU-US-Japan Trilateral Automation in Road Transport (ART) working group.
- Preparing for, and holding discussions at, meetings related to the above, as well as discussing with other related stakeholders within and outside Japan, including the International Standard Organization (ISO) and the Open Auto Drive Forum (OADF).

The main outcomes of the actions included:

- International understanding of dynamic maps.
- Arrangement of static map features.
- Promotion of SIP-adus field operation tests (FOTs).
- Moving standardization activities forward.

2 International Understanding of Dynamic Maps

2.1. Preparing visual contents

The concept underlying dynamic maps was defined as four layers of data progressing from static, semi-static, semi-dynamic to dynamic. There were several use cases involving employing dynamic maps in automated driving systems. The international cooperation team created presentations to facilitate understanding. Figures 1 and 2 present the results of that work. Figure 1 shows the whole concept underlying dynamic maps and their creation. It illustrates the four layers of data and was created from 3D common platform data including point clouds, graphics and probe data. It also shows that it was possible to use the data directly from vehicles via an API, as well as via OEM servers.

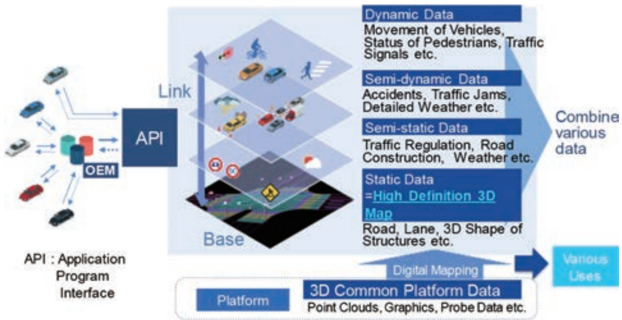

Fig. 1 Concept underlying dynamic maps

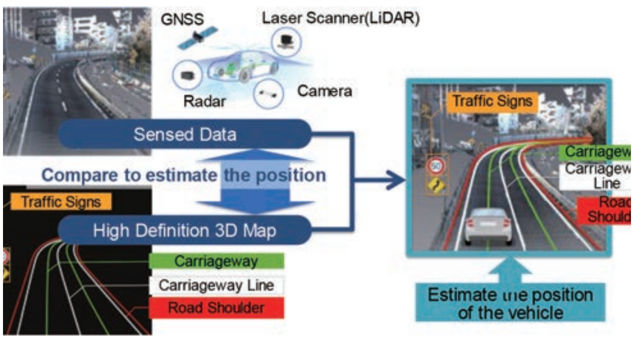

Fig. 2 Example of dynamic map use

Figure 2 shows an example of dynamic map use. It is possible to estimate the position of a vehicle by comparing the high definition 3D map data and the sensed data.

2.2. Presentations at conferences

Based on the results of the R&D and other prepared materials, the international harmonization team made presentations at conferences, including the ITS world congress, events held by TRB, TRA, AVS, and the European

Road Transport Telematics Implementation Coordination Organization (ERTICO), the OADF, the EU-US-Japan Trilateral ART WG and SIP-adus workshops. The team made presentations outside Japan ten times during FY 2017.

3 Arrangement of Static Map Features

SIP-adus has endeavored to harmonize static map features. The research team surveyed the automated driving systems use cases provided by the Japan Automotive Manufacturers Association (JAMA) and existing specifications in FY 2015 and selected 34 features. The team also discussed with major map providers in other countries and selected five features to harmonize.

In FY 2016, the team remodeled the map data based on the data list provided by JAMA, and re-selected 14 basic static map features. Table 1 shows the basic map features and the map features to harmonize internationally, which include:

- Center line
- Lane lines
- Lane edges
- Stop lines
- Pedestrian crossings
- Carriageway links

Table 1 List of features to harmonize

Category	Basic Features	
Real feature	<u>Road Shoulder</u> <u>Center Line</u> <u>Lane Line</u> <u>Lane Edge</u>	<u>Stop Line</u> <u>Pedestrian Crossing</u> Road Marking Traffic Signal Road Sign
Virtual feature	<u>Carriageway Link</u> Lane Link Common Location Reference Node	Intersection Lane Link Intersection Area

*Underlined features are the features to harmonize internationally

4 Promotion of SIP-adus FOTs

The research team and the international harmonization team actively worked to promote participation in FOTs from outside Japan. The contributions included translating related documents and specifications into English, preparing test static map data covering over 700 km, and presenting the FOT plans extensively.

As a result, 21 organizations participated in the FOTs. The organizations include major Japanese and German original equipment manufacturer (OEMs) and suppliers. Table 2 shows the participants in the FOTs.

Table 2 List of FOT participants

Daihatsu Motor Co., Ltd.	Mazda Motor Corporation
Continental Automotive Corporation	Mitsubishi Electric Corporation
Meiji Logitech Co., Ltd.	Mercedes-Benz Japan Co., Ltd.
Toyota Motor Corporation	Omron Corporation
Pioneer Corporation	Subaru Corporation
Suzuki Motor Corporation	Bosch Corporation
BMW Group Japan	Nissan Motor Co., Ltd.
Honda Motor Co., Ltd	ZMP Inc.
Alpine Electronics, Inc.	Saitama Institute of Technology
Volkswagen Group Japan KK	Nagoya University
Calsonic Kansei Corporation	Valeo Japan Co., Ltd.

*FOT participants are for dynamic maps or the human machine interface (HMI)

5 Support for Standardization

5.1. Support for ISO activities

SIP-adus supported several dynamic map-related ISO standardization items with ISO/TC204/WG3 members, include;

- ISO 17572-4: Precise relative location referencing.
- ISO 22726: Dynamic data and map database specification for connected and automated driving system applications.
- ISO 14825: Geographic data files (GDF).

In the context of international harmonization activities, the team supported the organization of a joint meeting with ISO/TC204/WG3 and the OADF. The meeting was held in July 2017 in Aix-en-Provence, France. At that meeting, both organizations informed each other of their status at the time and agreed to discuss further corroboration.

5.2. Collaboration with the OADF and Related Organizations

SIP-adus has discussed collaboration with the OADF several times since 2016. The team participated on an ongoing basis starting with the 5th meeting in October 2016 in Beijing, China. The team started to make presentations on SIP-adus dynamic maps at the 6th meeting.

SIP-adus and the OADF worked together to hold 8th OADF meeting in Tokyo in conjunction with SIP-adus WS 2017. The meeting was held in the same week as the WS, and many digital map professionals attended both events. The team also supported further collaboration, such as the SENSOR Interface Specification (SENSORIS) specification and the ERTICO workshop in Japan in 2018.

At the ITS world congress 2018 in Copenhagen, SIP-adus and the OADF organized a Special Interest Session (SIS). In that session, both representatives discussed related topics for further collaboration. Figure 3 shows one of the slides presented at the SIS. It explains the relationship between SIP-adus and other related standardization organization within the OADF.

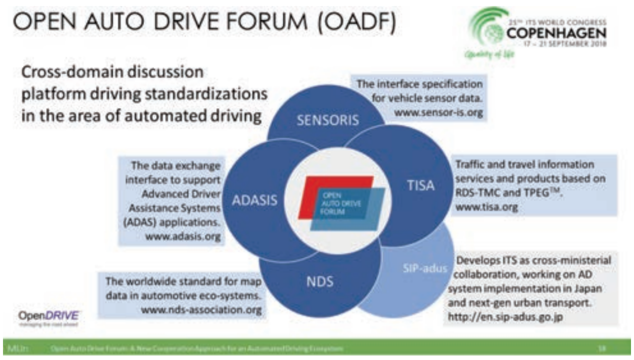

Fig. 3 Presentation at ITS world congress 2018

6 Conclusion

International harmonization activities for dynamic maps were actively pursued, and included fostering international understanding of dynamic maps, the arrangement of static map features, the promotion of SIP-adus FOTs, and moving standardization activities forward.

The R&D on dynamic maps and related dynamic data distribution by SIP-adus will continue. The relationship with related overseas activities is just at the beginning stage. Continuous actions will be needed to achieve the international harmonization of dynamic maps.

References

(1) Cabinet office of Japan: SIP-adus Dynamic Map Trial Production and Evaluation (FY 2015) (Japanese) http://www.sip-adus.go.jp/wp/wp-content/uploads/co_2015_co1-1_doc4.pdf

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Connected Vehicles

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1 Introduction

In terms of international cooperation activities concerning connected vehicles, we have focused on sharing information from Japan about how cooperative ITS with radio communication systems is being applied to automated driving, surveying the trends in Europe and the United States and transmitting the information we obtained to the people involved in Japan. The detailed activities include leading the SIP-adus Breakout Workshop, sharing and collecting information on the trilateral conference among Japan, the U.S, and Europe, participating in the international conferences on automated driving in Europe and the United States, as well as making presentations at conferences, visiting various projects conducted in Europe and the United States, exchanging information among members, and more. The activities are shown below.

2 Activities Summary

2.1 Conferences Attended

The conferences we attended are shown below.

(1) Oct., 2015 SIP-adus Workshop and Trilateral Meeting
(2) Apr., 2016 Transport Research Arena and Trilateral Meeting
(3) May, 2016 Grand Cooperative Driving Challenge, Final Event
(4) July, 2016 Automated Vehicle Symposium and Trilateral Meeting
(5) Nov., 2016 SIP-adus Workshop and Trilateral Meeting
(6) Jan., 2017 Transport Research Board and Trilateral Meeting
(7) Apr., 2017 Connected and Automated Driving Conference and Trilateral Meeting
(8) June, 2017 Drive Me (visiting) and Adaptive, Final Event
(9) July, 2017 Automated Vehicle Symposium and Trilateral Meeting
(10) Oct., 2017 ITS World Congress
(11) Nov., 2017 SIP-adus Workshop and Trilateral Meeting
(12) Jan., 2018 Transport Research Board and Trilateral Meeting
(13) Apr., 2018 Transport Research Arena and Trilateral Meeting
(14) June, 2018 ITS America Annual Conference, Connected Vehicle Pilot Program (NYC) (visiting) and Smart Columbus (visiting)
(15) July, 2018 Automated Vehicle Symposium and Trilateral Meeting

2.2 Conference Summary

Summaries of the conferences listed above are presented below.

(1) Oct., 2015: SIP-adus Workshop and Trilateral Meeting

Session

The U.S. Department of Transportation (USDOT) introduced V2X and truck platooning, which were conducted in New York, Tampa (Florida), and Wyoming, as a Connected Vehicle Pilot Deployment Program (CV Pilot).

The EU introduced truck platooning as well as a cooperative ITS corridor to connect the Netherlands, Germany, and Austria. They also introduced communication interoperability between European countries, the privacy of probe information, cybersecurity as future issues.

Breakout Workshop

The Michigan DOT from the U.S., a Dutch organization from the EU, as well as the Ministry of Internal Affairs and Communications, the Metropolitan Police Department, the National Institute for Land and Infrastructure Management, auto manufacturers, and electrical manufacturers from Japan took part in this workshop.

They exchanged information on current and future activities in their own countries, and shared issues about reducing accidents through the spread of connectivity.

(2) Apr., 2016: Transport Research Arena (TRA) and Trilateral Meeting

With respect to connected vehicles and security, it was agreed in the Trilateral Meeting that the exchange of information would continue. Also, the EU introduced the Declaration of Amsterdam, which was issued as a joint statement on automated driving by the Ministers of Transport in EU countries.

In TRA, a great deal of time was spent on automated driving and energy issues. We are facing the question of how to solve issues that cross national borders, such as the integration of measures from various countries and the commonization of communication infrastructures.

(3) May, 2016: Grand Cooperative Driving Challenge, final Event

The project started in 2011 and concluded in 2016. A large-scale verification test on the highway from Helmond, the Netherlands, was carried out over two days, demonstrating the performance of the cooperative vehicle–infrastructure systems with lane changes between platooning vehicles. After the event, we were able to have an information exchange with TNO (a research institution), which has been leading the project, allowing us to foster ties with Europe.

(4) July, 2016: Automated Vehicle Symposium and Trilateral Meeting

The EU reported that the AdaptiVe project, which made a comprehensive study of automated driving technology, the development of laws, and other factors, would complete the final demonstration at the end of June, 2017.

The U.S. announced that Columbus, Ohio had been chosen for the Smart City Challenge project aimed at solving overall urban transportation problems.

Japan introduced the national projects, such as a large-scale verification test starting in 2017 conducted as part of SIP activities.

(5) November 2016: SIP-adus Workshop and Trilateral Meeting

Session

The results of a SIP study indicated that a V2V emergency vehicle approach warning system could reduce the delay before the arrival of emergency vehicles. In addition, communication between vehicles on a main road and merging vehicles was reported to facilitate smooth merging.

Finland introduced its E8-Aurora project designed to offer a driving testing environment.

Breakout Workshop

The list of participants includes the European Commission, the Finnish MaaS Project, Spain, and Belgium from the EU, as well as automakers and electronic manufacturers from Japan.

With Japanese members introducing their activities related to various services utilizing signal information, the participants shared information of the status of practical use of ITS and held a Q&A session.

(6) January 2017: Transport Research Board and Trilateral Meeting

At the Trilateral Meeting, members discussed future connectivity-related activities and confirmed that information sharing would be their main focus.

The U.S. announced the guidelines for automated driving and the issuance of "Notice of Proposed Rule-making" concerning the mandatory installment of in-vehicle V2V devices. The EU announced its expected launch of a comprehensive project on automated driving. Some updates were shared with members, including the holding of the first international conference on automated driving.

(7) April 2017: Connected and Automated Driving Conference and Trilateral Meeting

This was the first expert conference on automated driving held in Europe.

There were many political reports presented, including the agreements on cross-border test zones (Cross Border Self-driving Test Zone between France and Germany), and cross-border legal frameworks for tests. Meanwhile, the industrial sector is actively working on matters such as situation-based use of 5G mobile networks and DSRC, with an eye toward automated driving.

(8) June 2017: Visit to Drive Me and Adaptive final event

Drive Me is a large-scale test conducted using 100 automated vehicles (Volvo-made). For one year starting in September 2017, it investigated the level of driver confidence in Level 4 automated vehicles and the level of traffic participants capability to interact with them, with the aim of elucidating the challenges involved in automated driving.

The Adaptive project is aimed at solving HMI related issues and legal challenges, including the social impact of the realization of automated driving (e.g., decreased CO_2 emissions, reduced number of accidents), through technological approaches, namely the development of automated vehicles, verification tests/simulations with those vehicles, and more.

· In the test-ride event, members test drove a Volvo truck performing automated driving on the Autobahn.

(9) July 2017: Automated Vehicle Symposium and Trilateral Meeting

Members visited Gomentum Station (a test course for automated driving). Currently, automated driving tests, safety support system tests, and last-mile evaluations using the EasyMile self-driving bus for unmanned driving, are underway.

At AVS, there were many reports on studies that center around automated vehicles being conducted to improve transportation services as part of more comprehensive efforts encompassing public transportation systems in the context of national- and state-level projects.

At the Trilateral Meeting, it was reported that many projects were brought to an end around 2017 in Europe, which has entered a new phase for launching next-generation projects.

(10) October 2017 ITS World Congress

In both America and Europe, measures to reduce traffic accidents, congestion, and CO_2 emissions have been taken by applying connected vehicles featuring automated driving and communication technologies. Such activities are progressing from the research to the large-scale test phase. The activities are taking comprehensive approaches that include not only the development of automated driving technologies but also the creation of legal systems and safety standards.

(11) November 2017 SIP-adus Workshop and Trilateral Meeting

Session

The United States team introduced two tests, the Connected Vehicle Pilot Deployment program and the Smart City Challenge. The European Commission started its Cooperative ITS (C-ITS) activities in 2014 and, in cooperation with automotive makers and public agencies released a report on C-ITS Platform Phase 1 in 2016. The following year, it announced Phase 2, which specified the tasks to address in 2017, and a revised version is planned for release in 2018.

Breakout Workshop

The participants included ERTICO and suppliers from the EU, USDOT and other groups from the U.S., and representatives of the Ministry of Land, Infrastructure, Transport and Tourism, vehicle manufacturers, electronics manufacturers, communication carriers, and other industries from Japan.

In terms of information sharing, issues concerning cross-border communication infrastructure and 5G usage were presented by the EU, while the U.S. talked about the CARMA project and investments in DSRC and other tests. Also, the expansion of the infrastructure remains an issue in each area.

(12) January 2018 Transport Research Board and Trilateral Meeting

In the U.S., the details of the CV Pilot have been made clear.

CARMA, a new automated driving project run by USDOT (FHWA), started considering a software platform for column traveling, speed adjustments, and crossing control.

Europe will launch the 5G Car project, which focus on studying communication systems for automated driving using mobile networks.

(13) April, 2018 Transport Research Arena and Trilateral Meeting

The EU issued the specification for the final stage of the ITS-G5 (DSRC), and announced that tests were to be performed in various countries, as it aims to achieve practical application starting 2019. In the meantime, the pace of forward-looking activities, including lively discussions on the 5G communication system (next-generation portable communication), has quickened.

(14) June 2018 ITS America Annual Meeting, Visit to Connected Vehicle Pilot Program (NYC), and to Smart Columbus

We visited the NYC Transportation Bureau (NYC DOT) and investigated the progress of the CV Pilot project and were given an on-site tour of a traffic control center in the NYC DOT.

At the ITS America annual meeting, Mark Reuss, VP at GM, gave a keynote speech on automated driving functions and V2X (DSRC) installation plans, which attracted the interest of the audience. Also, a number of reports on tests of safety driving support systems using V2X performed throughout the U.S. were provided at the session, indicating the steady progress of activities aimed at the practical applications of these systems.

We visited Columbus, Ohio to observe the Smart Columbus initiative, which studies the application of the latest technologies to achieve efficient urban transportation. The project will conduct tests on transportation as a whole, including the provision of traffic information to information terminals, automated driving technology to cover the last mile after the end point of public transportation routes, the use of electric vehicles, and truck platooning.

(15) July, 2018 Automated Vehicle Symposium and Trilateral Meeting

A report comparing the performance of DSRC and Cellular V2X was made by Qualcomm.

Cellular V2X has a longer wave propagation distance than DSRC. However, there were objections from the DSRC side.

The ICT4CART (an EU project) aims to utilize level 4 automation operations in the real world using various ICT technologies such as C-ITS, C-V2X, LTE, and G5 to increase the reliability of V2V, V2I, and V2N during transitions between each mode of communication.

① Leading International Debate on the Six Key International Collaborative Themes

Human Factors

Satoshi Kitazaki (National Institute of Industrial Science and Technology)
Makoto Ito (University of Tsukuba)
Tatsuru Daimon (Keio University)
Kiyozumi Unoura (Honda R&D Co. Ltd)
Hiroki Mori (Toyota Motor Corporation)
Takashi Sunda (Nissan Motor Co. Ltd)

ABSTRACT: The EU-US-Japan trilateral cooperation on human factors has been active since Japan joined the cooperation framework in 2015. The human factors WG has been discussing specific topics. The first topic was the Out-of-the-Loop Concept. The outcome of the discussions was summarized and published as a technical paper in 2018. The WG then started discussion on the next topic, mental models, and is planning to publish a paper in 2019. The human factors sessions in the SIP-adus Workshop have been great opportunities to promote the research and development activities on human factors in Japan, as well as to obtain valuable feedback for the project. Through international cooperation, the presence of Japan in the field of human factors has grown extensively.

1 Trilateral cooperation on Human Factors

1.1. Position of the Working Group

The Human Factors Working Group (WG) is officially placed under the Steering Group and expected to work on general human factors issues. However, the WG has been focusing on human factors in automated driving since Japan joined the WG in 2015. Therefore, the Human Factors WG and Human Factors Sub-Group under the Automation WG became one and the same (Fig. 1).

1.1. Members

The Trilateral Human Factors WG has been led by three co-chairs, Chris Monk, NHTSA, US, Johan Engström, Volvo, EU, and Satoshi Kitazaki, AIST, Japan. Emma Johansson (Volvo) took the co-chair position of EU when Johan Engström left in 2017. In each region, 5 or 6 human factors experts from academia, industry and government form a team under the leadership of the co-chair (Table 1).

1.2. Statement of Work made in 2018

Objective

- To share understandings of human factors in automated driving.

Scope

- Exchanging information about plans and findings of research on human factors in automated driving in each region.
- Identifying and discussing critical human factor issues that have not been highlighted.

Possible deliverables

- Reports/papers that summarize discussion

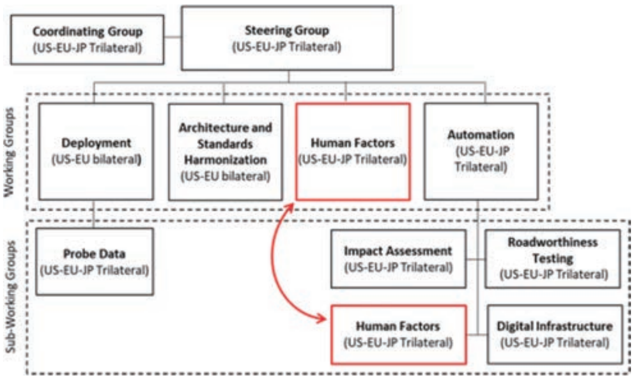

Fig. 1 Trilateral cooperation organization as of 2017.

Table 1 Members of the Human Factors WG (as of 2018)

United States	
Chris Monk, co-chair	NHTSA
Paul Rau	NHTSA
Dan McGehee	University of Iowa
Johan Engström	Waymo
Chuck Green	General Motors
Brian Philips	FHWA
European Union	
Emma Johansson, co-chair	Volvo group
Trent Victor	Volvo cars
Andreas Keinath	BMW
Anna Schieben	DLR
Natasha Merat	University of Leeds
Klaus Bengler	TU Munich
Japan	
Satoshi Kitazaki, co-chair	AIST
Kiyozumi Unoura	Honda
Hiroki Mori	Toyota
Takashi Sunda	Nissan
Makoto Itoh	University of Tsukuba
Tatsuru Daimon	Keio University

1.3. Achievements

1.3.1. Out-of-the-Loop Concept Paper

The loop concept is important in understanding driver engagement in the driving task with level 2 and level 3 automated driving systems. However, the terms, in-the-loop and out-of-the-loop, have been used with different concepts. Natasha Merat of the University of Leeds took the leadership of the project on this issue and invited more human factor experts to the WG in 2016. The WG worked on a technical paper to precisely define the concept and how it can be measured based on reviews of concepts in the literature. The definitions are given below. The paper was published online (Merat et al., 2018).

In the loop: In physical control of the vehicle and monitoring the driving situation.

On the loop: Not in physical control of the vehicle, but monitoring the driving situation.

Out of the loop: Not in physical control of the vehicle, and not monitoring the driving situation, OR in physical control of the vehicle but not monitoring the driving situation.

1.3.2. Mental models

The next focus, which had been discussed in the WG in parallel to the final phase towards the publication of the loop concept paper, was determined to be mental models. Trent Victor of Volvo volunteered to lead this new project in 2018. The user mental model may be considered the internal "picture" the user has of the system functions based on given knowledge. It may also grow through experiencing the system. An appropriate mental model is expected to shift a knowledge-based understanding of the system functions to a rule-based one, and make necessary driver responses quicker and faster. However, incorrect mental models may cause negative effects on users such as misuse or overtrust. The challenge is to design the system to foster an appropriate mental model in the driver. The target of the WG is to publish a paper in 2019.

2 SIP-adus Workshop

The field of human factors has been one of the areas of focus in plenary sessions and breakout sessions of the SIP-adus Workshop. The presenters in plenary sessions were from academia, industry and government in the EU, the US and Japan (Table 2). Activities, findings and plans concerning human factors in various sectors in various regions have been shared among the experts and the audience. The breakout sessions were organized as round-table or group discussions on specific topics (Table 3). The topics were chosen to be relevant to the SIP-adus human factors research project for the purpose of feeding discussion outcomes into the project. Posters were also presented every year on the progress of the SIP-adus human factors research project.

Table 2.1 Presenters and titles of presentations in the human factors plenary session at SIP-adus Workshop 2015

2015 Moderator: Satoshi Kitazaki, AIST

Presenters		Title of presentation
Myra Blanco	VTTI, US	Moving Ahead with Vehicle Automation
Tyron Louw	U of Leeds, UK	An Overview of European Activities on Human Factors of Vehicle Automation
Makoto Itoh	U of Tsukuba, Japan	Towards smooth and safe trading of control from machine to human
Eckard Steiger	Robert Bosch, Germany	HMI for Automated Driving
Motoyuki Akamatsu	AIST, Japan	Human Factors Issues in Interactions Between Human and Automated Vehicle
Steven Shladover	U.C. Berkley, US	Human Factors Challenges for Driving Automation Systems
Kiyozumi Unoura	Honda R&D, Japan	Humans and Automated Driving Systems: Human error and performance are two side of the same coin

Table 2.2 Presenters and titles of presentations in the human factors plenary session at SIP-adus Workshop 2016

2016 Moderator: Satoshi Kitazaki, AIST

Presenters		Title of presentation
Myra Blanco	VTTI, US	Mixed-Function Automation: Naturalistic Driving Study
Chris Monk	NHTSA, US	Automated Vehicles Research
Emma Johansson	Volvo, Sweden	HUMAN FACTORS IN VEHICLE AUTOMATION - Activities in the European project AdaptIVe
Natasha Merat	U of Leeds, UK	What information do cyclists and pedestrians want when interacting with a fully automated road transport systems
Daniel McGehee	U of Iowa, US	Engineering consumer understanding of higher levels of automation
Thomas Sheridan (Makoto Ito)	MIT, US (U of Tsukuba)	Some remarks on human factors in driving automation (vedeo); Makoto Ito ontroduced Sheridan
Satoshi Kitazaki	AIST, Japan	SIP-adus Human Factors and HMI research : on-going project

Table 2.3 Presenters and titles of presentations in the human factors plenary session at SIP-adus Workshop 2017

2017 Moderator: Satoshi Kitazaki, AIST

Presenters		Title of presentation
Daniel McGehee	U of Iowa, US	Assessing Driver Performance and Understanding in Automated Driving Systems
Brian Philips	FHWA, US	Opportunities for Connected Automation to Improve Safety
David Yang	AAA Foundation	Vehicle Technologies & Automation - Research on the "User Issue"
Peter Burns	Transport Canada, Canada	Safe Human-Machine Interfaces (HMI) for Automated Vehicles
Panos Konstantopoulos	Secured by Design, UK	In-Car Displays: Customer Expectations, Trends and Human Factors
Natasha Merat	U of Leeds, UK	Overview of Human Factors research on Automated Vehicles at Leeds
Makoto Ito	U of Tsukuba, Japan	SIP Human Factors Research Project Task A: Effects of system information on drivers' behavior in transition from auto to manual
Toshihisa Sato	AIST, Japan	SIP Human Factors Research Project Task B: Assessment of driver states in automated driving and Investigation of driver controllability in transition from automated to manual driving
Tatsuru Daimon	Keio U	SIP Human Factors Research Project Task C: Study of Communication between Automated Vehicle and Other Road User

Table 2.4 Presenters and titles of presentations in the human factors plenary session at SIP-adus Workshop 2018

2018 Moderator: Satoshi Kitazaki, AIST
Common theme: "What have we found? What's the next?"

Presenters		Title of presentation
Klaus Bengler	Technical U Munic, Germany	Communication and Interaction between automated vehicles and other road users
Peter Burns	Transport Canada, Canada	Human factors : unknowns, knows and the forgotten
David Yang	AAA Foundation	What have we found ? What's next Takeaways from AAA foundation's research
Michiaki Sekine	NTSEL, Japan	Issues related to human factors in international regulation activity of automated driving technologies
Satoshi Kitazaki	AIST, Japan	"What have we found? What's the next?"

Table 3 Topics of human factors breakout session at SIP-adus Workshop

Year	Topics
2015	What are the human factors problems / issues?
2016	TOPIC 1: Non-verbal communication between AV and other road users TOPIC 2: Driver monitoring
2017	Users' mental models and HMI/HMInteraction design, education and training
2018	What have we found? What's the next?

3 Conclusions

The trilateral cooperation framework and the annual SIP-adus Workshop have produced great opportunities to promote the research and development activities on human factors carried out in Japan, as well as to obtain valuable feedback to the project. Satoshi Kitazaki has been invited as the Principal Investigator of the SIP-adus human factors research project to many international workshops, conferences and meetings to present the progress and findings of the project. Through international cooperation, the presence of Japan in the field of human factors has grown extensively.

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Information Security

Takashi Imai (President, Toyota InfoTechnology Center Co., Ltd.)

1 Security

1.1. International Trends in Measures against Cyberattacks on Vehicles

Governments and industry groups are currently working on development of laws, regulations and guidelines in order to respond to cyberattacks on vehicles. The United States was the first to take action. In July 2015, the SPY Car Act was introduced in the Senate. The bill includes requirements to develop cybersecurity standards to protect vehicle control systems from hacking, standards to ensure privacy of the data collected in the vehicle and a cyber dashboard to rate how well vehicle security and privacy are protected. In 2016, Auto-ISAC and the National Highway Traffic Safety Association (NHTSA) issued, in January and October respectively, best practices related to automotive cybersecurity. Although some issues remain since the guidance introduced in these best practices were merely conceptual, they serve an important role in that certain degree of guidelines were presented by the government and industry groups that are in a position to impose directives on automakers. Along with these guidelines, the Society of Automotive Engineers (SAE) issued J3061 in January 2016 which specifies process-based cybersecurity measures. J3061 covers cybersecurity measures to consider in each phase of the product lifecycle from planning, development, and operation to the disposal of the product after its launch. However, much room remains for improvement, as no specific methods regarding threat analysis and risk assessment were identified in the guideline. In September 2017, the SELF DRIVE Act was passed by the House of Representatives. Section 5, CYBERSECURITY OF AUTOMATED DRIVING SYSTEMS, notably, requires auto makers to develop cybersecurity plans. The act applies to all non-commercial road vehicles to be sold after it comes into effect, and automakers must be aware of its importance as violating that law means they will not be allowed to supply any automated driving systems (including partially automated vehicles) to the US market. In Europe, hardware design for vehicle network and chips were studied in the EVITA project from 2008 to 2011. In the Working Party on Automated/Autonomous and Connected Vehicles under the United Nations WP.29 forum, Europe has been working to lead the development of a guideline to ensure cybersecurity and data protection for connected cars and automated driving. The contents were published in 2016 and will be updated as necessary in the future. In Japan, the Japan Automobile Manufacturers Association (JAMA), JasPar, and the Ministry of Land, Infrastructure, Transport and Tourism are working together to establish minimum mandatory standards for vehicle cybersecurity. Separately, the Society of Automotive Engineers of Japan (JSAE) has issued a cybersecurity analysis guide that summarizes the procedures for security activities ranging from threat analysis to the definition of cybersecurity requirements. The above presents the major trends in the United States, Europe and Japan, all of which are currently in a period of transition, which means that laws and guidelines are not fully established. The ISO and SAE aim to develop an international standard (ISO 21434) based on international consensus by 2020. Until that standard is issued, automakers will be required to takes into consideration the laws, regulations and guidelines previously mentioned and make their own decisions in establishing frameworks to ensure the security quality of their products.

1.2. Efforts to Share the Outcome of SIP-adus Globally

With these international trends in mind, we are working on the development of a security evaluation guideline to protect against cyberattacks as part of SIP-adus information security activities. The guideline simulates actual cyberattacks and is considered highly effective. The novelty in the evaluation method used in this guideline is that it specifies common procedures and evaluation criteria for penetration testing, the effectiveness of which is generally considered to be highly reliant on the individual skills of the tester. To assess the direction and necessity of the new evaluation method, we are closely monitoring trends in Japanese automotive industry groups such as JAMA and JasPar, as well as international standards (ISO 21434) and WP.29 initiatives while working to foster common understanding and urge the spread of penetration testing in the industry. In addition, we are consulting with the JSAE, which is in charge of ISO 21434 and the National Traffic Safety and Environment Laboratory, which is promoting discussion on information security at WP.29, in order to ensure that our project contributes to leading international discussions.

About the author

1) Takashi Imai, President, Toyota InfoTechnology Center Co., Ltd.

Impact Assessment

Nobuyuki Uchida (Japan Automobile Research Institute) and Hiroaki Miyoshi (Doshisha University)

ABSTRACT: Automated vehicles have the potential to transform the world's road transportation system. Expected benefits include traffic safety, transport network efficiency, energy/emissions, and personal mobility. Furthermore, as the existing transport systems are complex, prior to implementation, automated vehicle technology must be understood and its effects carefully predicted prior to implementation to plan for that transformation. This article introduces the international activities of SIP-adus with regards to assessing the impact of automated vehicles from the following three perspectives: the Trilateral Impact Assessment Sub-Group for ART, as well as both safety and socioeconomic impacts.

1 Introduction

Automated vehicles (AVs) have the potential to transform the world's road transportation system. The potential benefits include traffic safety, transport network efficiency, energy/emissions, and personal mobility. As it is being introduced into existing complex transportation systems, AV technology must be understood and its effects carefully predicted prior to implementation to adequately plan for that transformation. In this article, we introduce international activities with regards to assessing the impact automated vehicles from the following three perspectives: the Trilateral Impact Assessment Sub-Group for ART, as well as both safety and socioeconomic factors.

2 Trilateral Impact Assessment Sub-Group for ART

Members of the Trilateral Working Group on Automation in Road Transportation (ART WG) are working to address the complexity of the impact of AVs in various areas. European researchers are looking at the possibility of applying the Field Operational Test Support Action framework (FESTA, FOT Net 2016) to automation and sketching the mechanisms through which automation potentially affects our lives. The United States Department of Transportation (US DOT) has sponsored the development of a modeling framework that includes the areas of safety, vehicle operations, personal mobility, energy/emissions, network efficiency, travel behavior, public health, land use, and socioeconomic impact. Japan has been developing models of the impact on safety since late 2015 under SIP-adus.

To coordinate the impact assessments performed in the field of automated driving, the ART WG established an Impact Assessment sub-group in 2015. The motivation was the realization that, as field tests are expensive and mostly done on a small scale, international harmonization would be in everyone's interest. With a harmonized approach, tests and studies can be designed to maximize the insights obtained and arrange complementary evaluations around the world.

The framework aims for high-level harmonization of impact assessment studies globally. It is the first attempt at harmonization by the three regions involved (EC, US and Japan). As automated driving covers many concepts, the framework does not give detailed methodological recommendations (i.e., methods to apply for calculating the strength of various impacts) but it aims to facilitate meta-analysis across different studies. Therefore, the focus is on providing recommendations on how to describe the impact assessment study in a way that users of the results understand what was evaluated and under which conditions.

The areas of AV impact may be divided into two large groups: direct and indirect. Figure 1 depicts the impact areas (Smith, 2017). Direct impacts are those which have a clear cause-effect relationship with the primary activity or action. They are easier to capture, measure and assess, and are often (though not always) immediate to short-term in nature. In Fig. 1, they are in the upper left, and include safety, vehicle operations, energy/emissions and personal mobility. The others are indirect impacts. Indirect impacts can be characterized as secondary, tertiary, or still further removed from the original direct impact.

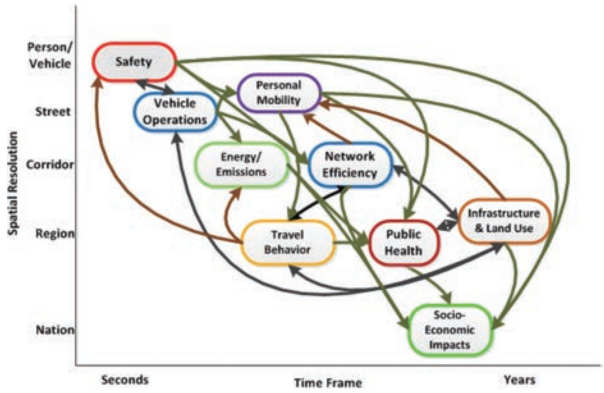


Fig. 1 Framework of impact areas (Smith, 2017)

Direct Impacts are those that can be measured in a field operational test (FOT). They then can be scaled up to a national level and will also lead to indirect impacts. An FOT can also provide insight into the infrastructure requirements of an automation application.

3 Methodology of Safety Impact Assessment

Nearly all AV applications, ranging from Level 1 collision avoidance systems to Level 5 self-driving vehicles, have potential safety impacts. Ultimately, safety should be measured by accident statistics, such as fatalities, injuries and property damage for vehicle occupants and other road users. Other road users may include pedestrians, cyclists, and slow-moving vehicles. One challenge with safety impact assessment is that actual crashes are rare events, even with a considerably large-scale FOT. Therefore, proxy measures are often used.

In Japan, a novel multi-agent traffic simulation software was developed as a part of the SIP-adus projects. The software can simulate and identify at least five types of accidents. Different automated driving technology penetration scenarios can be set to estimate the potential impact of different technologies on safety. A summary of the achievements of the research project is described below.

Figure 2 shows a simulated area created to model a part of Tsukuba City in detail. The road network was composed of various routes such as an expressway, major roads, and old narrow streets in order to verify the simulation program.

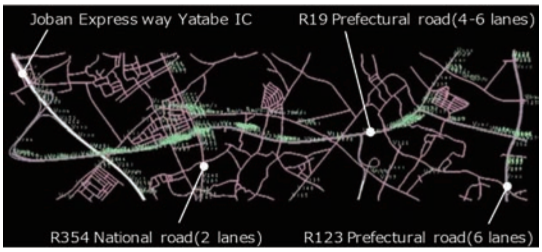


Fig. 2 Road network for verification of simulator functions

Typical automated driving penetration rates are entered in order to compute and compare the results of diverse technology penetration scenarios. There are multiple driving modes including manual driving, autonomous emergency braking (AEB), lane departure warning (LDW) and automated driving (Table 1). It is important to set up mixed scenarios consisting of various driving modes to achieve a more practical estimation of safety impacts.

Table 1 Technology penetration scenarios

Simulation Scenarios	1	2	3	4	5
Manual Driving(MD)	100	50	25	25	-
Autonomous Emergency Braking(AEB)	-	50	25	-	-
AEB + Lane Departure Warning(LDW)	-	-	50	50	25
Automated Driving(AD)	-	-	-	25	75

In order to estimate possible accident reduction effects, it is essential to reproduce a realistic traffic flow via simulation. There are approximately 500 agents that can behave individually in our current simulation (Fig. 3). Traffic density and travel velocity are pre-set based on road traffic census data.

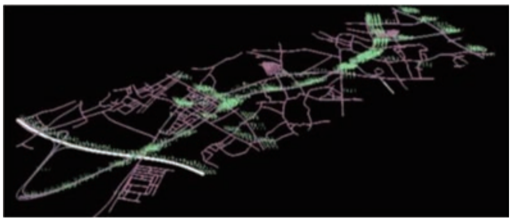


Fig. 3 Multi-agent traffic simulation including 500 agents

As shown in Table 2, under 100% manual driving, the system simulated a total of 859 accidents categorized in five types. The number of accidents predicted decreased as the level of automation increased, coming down to 156 cases for the highest automation level simulated (25% of vehicles with AEB+LDW and 75% of Level 4 automated driving). Figure 4 shows that all the technologies considered contributed to the absolute decrease in accidents, which was predominantly represented by the reduction of rear-end and lane departure-related crashes.

Table 2 Synoptic table of simulation results

No.	Total			MD	AEB	AEB LDW	AD
	NoA [Freq.]	AR [Freq. /km]	RAR [%]	RAR [%]	RAR [%]	RAR [%]	RAR [%]
1	859	0.011	100	100			
2	622	0.008	70	101	41		
3	463	0.006	56	113	46	36	
4	430	0.005	46	116		30	14
5	156	0.002	16			29	12

NoA: Number of Accidents, AR: Accident Rate, RAR: Relative Accident Rate

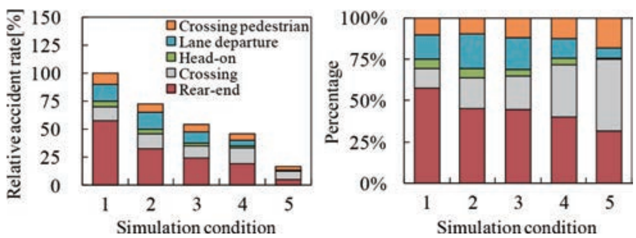


Fig. 4 Comparison of relative accident and component rates

The above results in the SIP-adus project were presented at the Autonomous Vehicles Symposium 2018 in San Francisco (Kitajima et.al., 2018) and drew the interest of the international community of experts. Several research groups expressed considerable interest in the multi-agent traffic simulation model, and future collaborative research regarding the simulation model is expected. Such international collaboration and discussions can address the methodology of safety impact assessment.

4 Economic Analysis of Safety Impacts

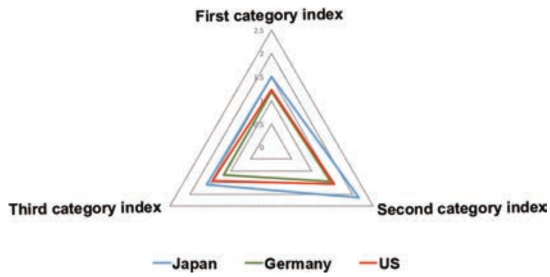
We also conducted analysis on safety impacts from the viewpoint of economic factors. Compared to passive safety technologies, one of the most distinctive features of automated driving systems lies in the fact that the economic benefits of those systems will be enjoyed not only by their users, but also by non-users. With AEB, for example, preceding vehicles will benefit more than following vehicles equipped with on-board devices, regardless of whether devices are install in the preceding vehicles or not. It can also be said that automated driving systems are safety-sharing systems. From an economics viewpoint, this implies that it is difficult for automated driving systems to be diffused properly via market mechanisms. Thus, economic incentives will be necessary to facilitate the diffusion of automated driving systems in society. We initiated international discussion on these points at several international conferences (See Miyoshi, 2017).

5 Socio-Economic Impacts

Automated driving will bring about various significant socioeconomic impacts.

The decrease in the opportunity cost of traveling when SAE levels 4 and/or 5 automated driving becomes widespread in society could dramatically change human lifestyle, for example.

The national economy will also be affected by automated driving, which will significantly change the cost and cost structure of vehicles thanks to the change of inputs. In addition, some advocates claim that automated driving will result in a decrease in vehicle sales and ownership due to the widespread use of car sharing and ride sharing. It is possible that automated driving will significantly impact the Japanese industrial structure. We estimated three categories of indexes of the power of dispersion of the automotive sector. The first category denotes the relative size of the influence on the entire industry (including the self-sector) in a case where the final demand for the industry increases by one unit. The average value is 1. The greater the value of an industry, the more heavily that industry affects the whole sector. The second and third category indexes are modifications of the first category. The third category index denotes the impacts on other sectors. The effect on the self-sector is totally excluded. In the second category, only direct effects of 1.0 on the self-sector are excluded. Figure 5 shows the three categories of indexes for Japan, Germany and the US. Japan has the largest value in each of the three categories, indicating that, among the economies of those three nations, the Japanese economy will be the most affected by the diffiusion of automated driving systems. We discussed this issue at the ITS World Congress 2017 (See Miyoshi and Kii, 2017)



Note) Calculated by author for the sector of "Motor vehicles, trailers and semi-trailers".
Data) 2011 Input-Output Tables compiled by OECD. Stat
Source) Miyoshi and Kii (2017)

Fig. 5 Indexes of the Power of Dispersion of Automotive Sector

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① Leading International Debate on the Six Key International Collaborative Themes

International Cooperation Activities for Next-Generation Transport

Masayuki Kawamoto (University of Tsukuba)

ABSTRACT: Next-generation transportation and logistics are getting more attention as practical early applications of automated vehicle technology as well as related innovative new services. Low-speed automated shuttles represent one of the major topics in this area and are the subject of demonstrations with several business models targeting improvement in quality of life. Walking always accompanies the use of public transport in daily life. Therefore walking support systems, especially for vulnerable road users, are key to promoting public transport that encompasses upcoming shared mobility. Realizing driverless vehicle is still years away, but several applications making use of automated vehicle technologies are being introduced to contribute reduction in traffic accident fatality.

Automated Public Transport Topic Trends

At almost the same time as our SIP-adus activities were launched in 2014, several existing international conferences started to include sessions relating to automated vehicle systems. At those conferences, topics relating to public transport and its services were few because the small size of the market for automated vehicles for public transport did not draw much interest from major IT and auto manufacturers. Recently, however, the situation has been changing, and automation in public transport and freight vehicles, as well as related services, has been gathering attention.

Low-Speed Automated Shuttles

The major drivers of this trend were not IT giants or major auto manufacturers, but rather small startup companies. One of the triggers for this development was the CityMobil2 project, partially funded under the auspices of the EU's Seventh Framework Programme for Research (FP7) which ran from 2007 to 2013.

EasyMile and Navya from France developed their automated shuttle for CityMobil2, which was a pilot demonstration project for automated road transport systems across Europe. BestMile from Switzerland developed operation service systems for those automated shuttles. Now EasyMile, Navya and BestMile are providing their products worldwide including in the U.S. and Japan.

Fig. 1 CityMobil2 Project

Fig. 2 EasyMile EZ10

Fig. 3 Navya ARMA

Fig. 4 2getthere

Fig. 5 Local Motors Olli

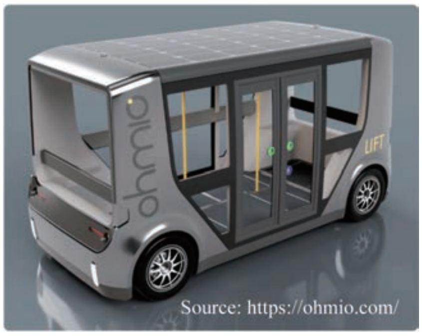


Fig. 6 Ohmio LIFT

Another automated shuttle maker that is a little older than the above companies, 2getthere from the Netherlands, has also been providing commercial operation transport products worldwide.

Olli, developed by Local Motors in the U.S., and Ohmio from New Zealand, are automated shuttles offering a unique concept and features that differ from the offerings of the French makers.

Despite a background and environment favorable to manufacturing such vehicles, Japan is still struggling to bring out original products.

The e-Palette concept from Toyota, which debuted at CES 2018, provides a ray of hope for the future of the automotive industry in Japan.

Fig. 7 e-Palette Concept

Working Vehicle Automation

One reason for focusing on low-speed automated shuttles as a practical application of vehicle automation is their limited operational domain. This makes it possible to choose or set up a less critical domain for their operation where most risks can be predicted and avoided.

Similarly, long distance freight trucks and working vehicles such as refuse trucks and road cleaning vehicles represent another area of focus for the practical application of automated driving. Automated truck platooning projects are being conducted in the EU and the U.S., as well as in Japan.

Fig. 8 Automated Refuse Truck

Fig. 9 Truck Platooning

The challenge of building self-driving trucks is being met by Einride of Sweden which is developing the T-pod, which is remotely controlled by the driver and the T-log, which features automated driving capability.

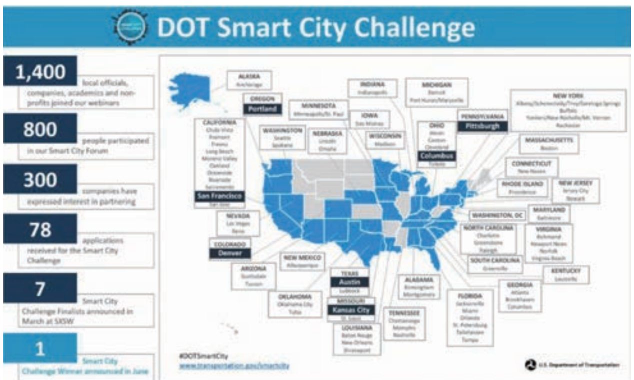
Fig. 10 T-pod

Fig. 11 T-log

Expanding Demonstrations from Small Sites to Entire Cities

In their initial stage, most automated driving shuttle demonstration projects have been carried out in relatively limited areas like private campuses or small parks. However, some of those demonstration projects are now expanding their concepts to entire cities, as exemplified by the Smart City Challenge in the U.S.

In 2016, USDOT selected the city of Columbus Ohio as the winner of its call for Smart City Challenge proposals. This kind of project is not being conducted only in Columbus, but also in several cities in the U.S., with funding from several sources.



Source: https://www.transportation.gov/smartcity/highlights

Fig. 12 USDOT Smart City Challenge

After those projects expanded to entire cities, automated mobility became only one factor in innovation. Smart cities utilizing AI, IoT, open/big data, and renewable forms of energy are targeting improvements to the quality of life for all citizens. Valuable mobility-based services have emerged as a new area of focus called mobility as a service, or MaaS.

Mobility as a Service

MaaS is one of the biggest areas of focus in current international conferences for automated vehicle systems and intelligent transportation systems (ITS). There was a period of a few years when automated vehicle-related conferences only covered the topic of mobility services in the titles of a few presentations, but it is now found in several session titles, and is sometimes even the subject of the whole conference.

The definition of MaaS is still unclear. However, it should consist of new service value associated with mobility, rather than merely simple transportation from A to B and its attendant services. New service value will follow new business models such as integrated sharing services or completely different cost allocations. It will take a little more time for industry to find practical MaaS solutions.

User Acceptance of Automated Vehicles

Some demonstration projects are venturing to conduct their operation in spaces that include pedestrians, taking maximum care to avoid accidents, in order to evaluate user acceptance of automated shuttle by both passengers riding the vehicles and the pedestrians in the vicinity of the vehicle. The GATEway project in Greenwich, UK is one example, as is the Mcity project in Michigan, USA. Of course, obtaining conclusive results concerning user acceptance applicable to various people will take time, but is also definitely an important process to implement future regular operation of automated shuttles in shared spaces and similar areas.

Fig. 13 GATEway project

Fig. 14 Mcity project

User acceptance studies have usually been conducted through questionnaires involving a limited number of participants and a short evaluation period, but their results have always included an unrealistically hopeful bias because most demonstrations were carried out under ideal conditions. A realistic user acceptance study, such as the one by PostBus in Sion, Switzerland, must consider daily regular operation in a general (rather than ideal) environment.

Fig. 15 PostBus SmartShuttle in Sion

Vulnerable Road User Support Systems

The activities of the Accessible Transportation Technologies Research Initiative (ATTRI) of USDOT have served as a reference for SIP-adus. Rather than the aging society challenge faced by Japan, the ATTRI activities address the many veterans who need mobility services providing additional care. The two situations are similar in terms of the need for mobility service offering several modes that cater to diverse groups of people.

Source: https://www.its.dot.gov/research_areas/attri/

Fig. 16 Diversified mobility services ATTRI

What We Have Learned and What We Should Do

The current results of several automated driving field tests around the world indicate that realizing fully automated driverless vehicles on public roads is still years away. In the near future, even without a driver, introducing automated vehicle services in actual markets will still require additional labor for tasks such as maintaining the vehicles and their dedicated infrastructure, securing operational safety, and providing emergency support.

Continuous step-by-step studies are still required to reach our goal, which, it must be noted, is not to develop self-driving vehicles. Our final goal is zero traffic accident fatalities. There are still issues to resolve before self-driving can improve the safety and efficiency of public transportation and logistics through the use of automated technology in preparation for future self-driving.

② Promotion of International Standardization

Activities toward International Standardization of Dynamic Maps

Hiroki Sakai (Mitsubishi Research Institute, Inc.), Sumio Nishiyama (Kiwi-W Consortium)

ABSTRACT: In order to contribute to the international community, SIP-adus has supported the development of international standards for the logical data model referenced by applications such as automated driving systems and for lane-level location referencing. For the logical data model, an input proposal was developed by examining data models that will be necessary for those applications. For lane-level location referencing, a proposal for an international standard was created from use cases, requirements and general concepts for lane-level location referencing. SIP-adus will continue to support the international standardization of dynamic maps.

1 Purpose of Activities

As part of the cross-ministerial Strategic Innovation Promotion Program (SIP) activities covering automated driving systems (ADS), dynamic maps are being developed as maps used in such systems. In order to contribute to the international community, SIP-adus aims for the international standardization of this outcome. Based on the history of ISO/TC204/WG3 (ITS database technology), which has promoted the international standardization of car navigation maps, candidates for the international standardization of dynamic maps are (1) data exchange, (2) API, (3) the data model (description of data type/attribute structure, methods of maintaining relevance between data items, etc.), and (4) lane-level location referencing method for data exchange. Data exchange is already under development as GDF 5.1 (20524), an extension of GDF 5.0, which is an existing standard in ISO/TC204/WG3. For the second candidate, it is difficult to specify API without a data model. In light of this situation, SIP-adus has supported the development of an international standard for the logical data model referenced by applications such as ADS and for lane-level location referencing.

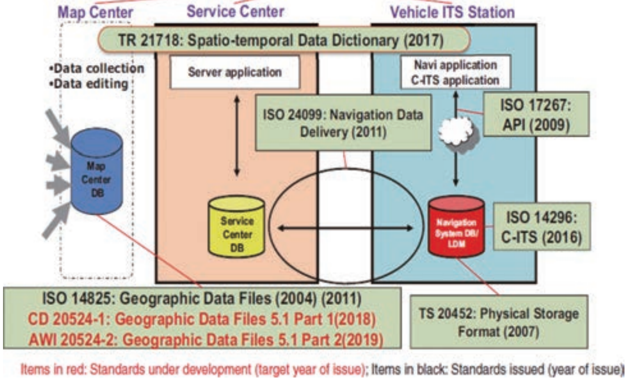


Fig. 1 Relationship between ISO/TC204/WG3 Work Items.(1)

2 Standardization of Logical Data Model

2.1. Overview

This work item standardizes the logical data model referenced by applications such as ADS.

The data envisioned for use in ADS is categorized into static data (i.e. maps for high levels of driving automation and traditional map data) and dynamic data (e.g. traffic and travel information). These types of data are interconnected to realize ADS. The data model for ADS shall have a structure specialized for driving automation and designed to be shared with other systems. GDF 5.1 provides detailed road data as static map data for ADS. ISO 14296 specifies the static map data and the attendant logical data model for car navigation systems and cooperative ITS. Furthermore, dynamic data has already been specified and used in many existing systems. Although it is necessary to specify the relationship between map and dynamic data envisioned for use in ADS, no such relationship has been provided so far.

Thus, the data system architecture related to the static and dynamic data flow was examined and, based on the results, the logical data model was assessed, and an input proposal was developed by examining other data models. The specification on map features and attributes for ADS provided by the Japan Automobile Manufacturers Association was referenced when considering the necessary features. The implementation of this specification could lead to cost reductions in the maintenance and expansion of map access libraries, as well as in the compilation and maintenance of map and map-related data for data providers, as well as for connected and driving automation/vehicle control applications.

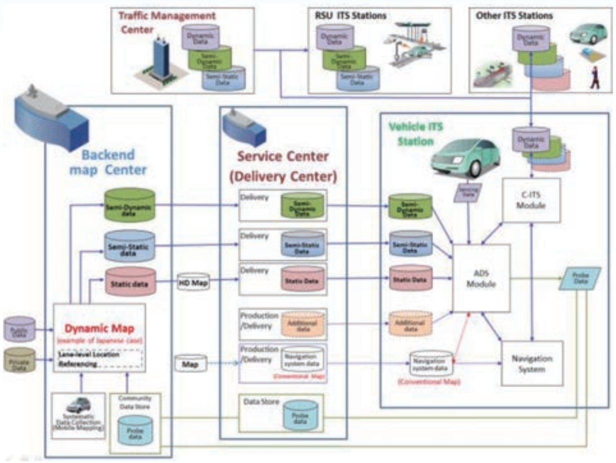


Fig. 2 Proposed Architecture for Automated Driving System

2.2. Status of International Standardization

This work item was conditionally approved as PWI (22726) in April 2017. After that, in October 2017, through expanded joint meeting with existing WGs and external SDOs, the Japanese delegation explained the scope of this work item and the contents of work to plan in the future, while ensuring that there is no conflict with the existing standards and establishing a cooperative relationship with these WGs and SDOs. At the international conference in April 2018, it was agreed to establish Part 1 as Architecture and data model for harmonization of static map data and Part 2 as Data model of static transitory and dynamic transitory data, and that the resulting documents would be published as TS. Part 1 was approved as an NP in August 2018 and it is scheduled for publication as a TS in spring 2020. Part 2 is planned to be moved to an NP proposal after a consensus on the data type classification and data items subject to standardization is reached (as of September 2018).

3 Standardization of Lane-Level Location Referencing

3.1. Overview

This work item standardizes location referencing capable of locating an object on a road within a specific lane.

ISO 17572 Part 1, Part 2 (pre-coded), Part 3 (dynamic) have been published as the international standards for location referencing methods. However, none of them handles location referencing at the lane level. Furthermore, there is no other widely used standard covering location referencing at that level. Thus, a proposal for an international standard was created from use cases, requirements and general concepts for lane-level location referencing.

There are two ways to reference location:

Method 1: Lane number counting

Method 2: Delta from a reference point

The method used is selected according to road segment type and/or usage. As a general rule, Method 1 is used to represent events in lanes (excluding intersections) and Method 2 is used to represent events at junctions. However, Method 2 can also be used to represent events in lanes.

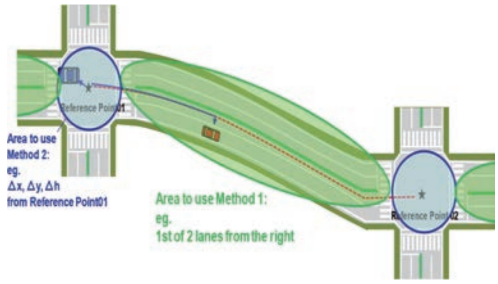


Fig. 3 Lane-Level Location Referencing Methods

3.1.1. Method 1: Lane Number Counting

The longitudinal location shall be referenced using a distance along a road section and a lane number counting rule. The distance along a road section shall be expressed as a percentage of the road section or a real distance. The vertical location shall be expressed as a distance from the road section. This method is used for the situations described below.

- Road segments that have lane information.
- Specifying the lane.

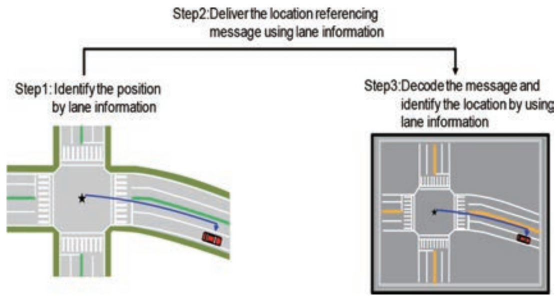


Fig. 4 Explanation of Method 1

3.1.2. Method 2: Delta from a Reference Point

The location shall be referenced using the distance from a reference point (Δx, Δy, Δh). This method is used for the situations described below.

- Road segments in junctions.
- Specifying the relative position within a road (e.g. σ<25 cm accuracy).

In order to achieve a location measurement accuracy with a margin of error of σ<25 cm with this method, the following condition shall apply:

- The method is used within a radius of no more than 200 meters from the reference point.

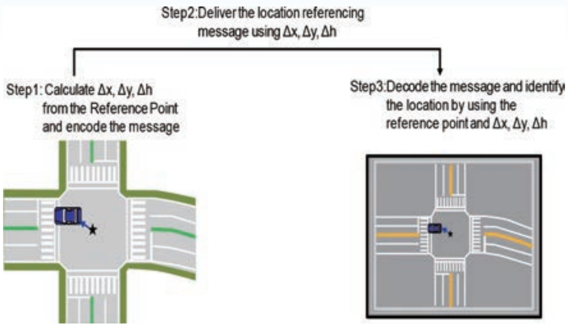


Fig. 5 Explanation of Method 2

3.2. Status of International Standardization

This work item received NP approval in April 2017. The CD ballot ended in July 2018, and CD comment resolution concluded at the international conference in September 2018. It is scheduled to move to a DIS ballot proposal in December 2018 and be published as an IS in the summer of 2019 (as of September 2018).

4 Conclusion

In order to contribute to the international community, SIP-adus has supported the development of international standards for the logical data model referenced by applications such as ADS and for lane-level location referencing. For logical data models, an input proposal was developed by examining other data models. As of September 2018, Architecture and data model for harmonization of static map data has been approved as an NP (22726-1). SIP-adus will continue to support international standardization, aiming for publication as a TS in the spring of 2020. In the dynamic maps for ADS proposed by Japan, how to associate externally provided information with map information is an important consideration. Thus, in its examination of static transitory data, dynamic transitory data and dynamic data, SIP-adus will support cooperating with existing WGs and external SDOs to avoid conflicts with related existing standards. For lane-level location referencing, a proposal for an international standard was created from use cases, requirements and general concepts. SIP-adus will continue to support international standardization, aiming for publication as an IS in the summer of 2019.

References

(1) ITS Standardization 2017: Society of Automotive Engineers of Japan, http://hq.jsae.or.jp/its/2017_bro_e.pdf (September 12, 2018)

General Survey of International Trends Regarding International Cooperation with Dynamic Maps

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ABSTRACT: In order to contribute to the international community in the promising field of dynamic maps, a field expected to be integral to driving automation systems, SIP-adus investigated dynamic map data models and the map data structure of dynamic maps both in and outside Japan. Furthermore, this study worked to clarify differences in specifications of dynamic maps established by various nations. To achieve compatibility between industry standards in Japan and in other countries, it also aimed to reinforce cooperative ties, through exchange of views and debate, between organizations worldwide that conduct research and development in the driving automation field.

1 Research Objectives

In order to contribute to the international community in the promising field of dynamic maps, a field expected to be integral to driving automation systems, SIP-adus investigated dynamic map data models and the map data structure of dynamic maps both in and outside Japan. Furthermore, this study worked to clarify differences in specifications of dynamic maps established by various nations. To achieve compatibility between industry standards in Japan and in other countries, it also aimed to reinforce cooperative ties, through exchange of views and debate, between organizations worldwide that conduct research and development in the driving automation field.

2 Investigation of Dynamic Maps

The investigation gathered information such as the details of standardization documents and activities surrounding the formulation of industry specifications for dynamic maps. This was done through surveying public materials and exchanging information with industry players at conferences and in individual meetings.

Table 1 Main Initiatives in the Global Formulation and Development of Dynamic Map Specifications.

Standardization Level	Domestic/ Int'l	Organization	Specifications
Industry Standards	Domestic	SIP-adus	Dynamic Map Specifications for Dynamic Map Field Operational Tests
	Int'l	NDS	Navigation Data Standard Open Lane Model 1.0
		ADASIS	Advanced Driver Assistance Systems Interface Specification
		TISA	Traffic Message Channel (TMC) Transport Protocol Experts Group (TPEG)
		SENSORIS	Sensor Ingestion Interface Specification
		OADF	–
International Standards	–	ISO/TC204	22726 : Dynamic events and map database specifications for applications of automated driving systems, cooperative ITS, and advanced road/traffic management systems
			20524 :Geographic Data Files – GDF5.1

2.1. Initiatives outside Japan

The investigation compiled details concerning the activities of European organizations that are actively developing industry standards.

2.2.1. NDS

The Navigation Data Standard Association aims to develop a standard database format that is compatible with all car navigation systems.

The Navigation Data Standard (NDS) is a standard database format that maintains compatibility with all systems. It separates the software and map data, and features immediate data updates.

2.2.2. ADASIS

The Advanced Driver Assistance Systems Interface Specification Forum (ADASIS) aims to develop an interface for ADAS applications and onboard maps.

The Advanced Driver Assistance Systems Interface Specification is an application interface for vehicle control that provides map information to ADAS.

2.2.3. SENSORIS

Initiated by HERE, SENSORIS aims to develop open standards such as a format for processing and analyzing information collected in the cloud from vehicle sensors.

It is studying specifications for uplinking vehicle sensor data to a cloud center and those necessary for services that result from the realization of vehicle sensor data.

2.2.4. TISA

The Traffic Information Service Association (TISA) aims to develop open standards for traffic information and traveler information services.

It is developing two formats: TMC, for the transfer of traffic, weather and other information over FM channels, and TPEG, which uses digital broadcast to transfer information related to traffic, public transport, the weather, and more.

2.2.5. OADF

The Open AutoDrive Forum, consisting primarily of European organizations (NDS, ADASIS, TISA, SENSORIS) and related companies, is a platform that promotes cross-domain debate and coordination to advance driving automation.

It promotes the Auto Drive Ecosystem, which is a cycle of map production, delivery to vehicle, onboard cooperation with ADAS modules, and vehicle (sensors) data feedback.

It has 61 participants, including auto makers and map providers (as of Feb 2018).

It organizes meetings once every two or three months in Europe, the U.S., or Asia.

2.2. Initiatives in Japan

So far, SIP-adus has created documents defining requirements (draft) and specifications for basic map data and production (draft) for dynamic maps.

It has also created prototypes of high-accuracy 3-dimensional maps and conducted field operation tests.

As of December 2017, it has provided data for a subset of local roads and expressways.

2.3. International Initiatives

Under TC 204, the technical committee for ITS standardization within the ISO, WG3 is working on the standardization of geospatial information and related matters with ITS database technology at its core.

It defines the relationship between semi-static/semi-dynamic data and static data for dynamic maps. As of September 2018, the architecture and data model for harmonization of static map data has received NP approval.

Besides the logical data model, there is current deliberation that aims for the publication of geographic data file GDF5.1 (CD 20524-1, AWI 20524-2) and lane-level location referencing (NP 17572-4) by the ISO.

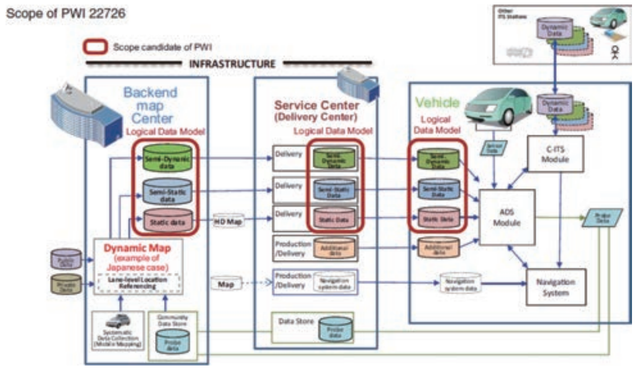

Fig. 1 Scope of PWI 22726.

Source: ITS Standardization 2017: Society of Automotive Engineers of Japan, http://hq.jsae.or.jp/its/2017_bro_e.pdf (September 12, 2018)[1]

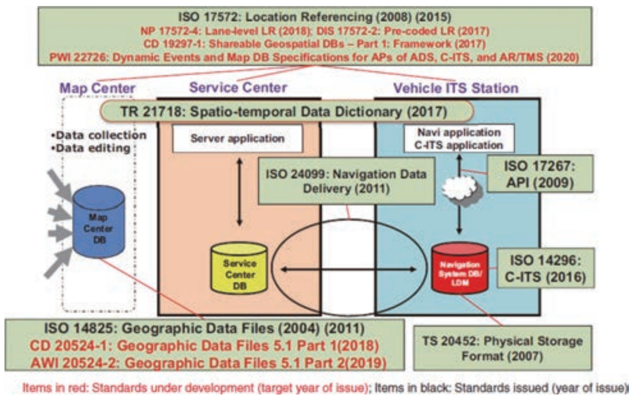

Fig. 2 Relationship between ISO/TC204/WG3 Work Items.

Source: ITS Standardization 2017: Society of Automotive Engineers of Japan, http://hq.jsae.or.jp/its/2017_bro_e.pdf (September 12, 2018)[1]

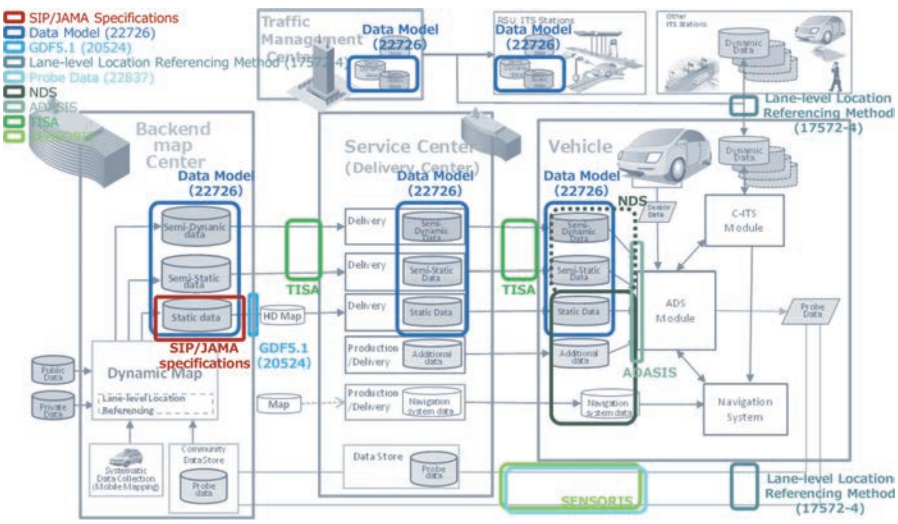

Fig. 3 Japanese and International Activities Related to Dynamic Maps

Source: Created based on ITS Standardization 2017: Society of Automotive Engineers of Japan, http://hq.jsae.or.jp/its/2017_bro_e.pdf (September 12, 2018)[1]

2.4. Japanese and International Activities Related to Dynamic Maps

Domestic and international activities related to dynamic maps are shown in Fig. 3.

3 Cooperation with Related Organizations

The investigation disseminated information regarding the progress of current initiatives in Japan, and sought cooperative partnerships with appropriate organizations through participation in conferences like OADF, as well as exchanges of information with relevant parties.

Table 2 Participation in Conferences Hosted by Relevant Organizations.

Conference	Date	Location	Conference Summary
8th OADF	November 13, 2017	Tokyo, Japan	• Presentation of current state of SIP-adus - Welcome Speech by Mr. Fukushima Overview of SIP and description of items being considered with regard to automated driving systems - Keynote Speech by Mr. Ozawa, Dynamic Map Platform Co., Ltd. Presentation of the current situation regarding the maintenance of high-accuracy 3D map data at DMP and initiatives for map data maintenance updates - SIP-adus Presentation by Dr. Nakajo, University of Tokyo Presentation of verification experiment objectives, test items, distribution data (data items) and overview of data maintenance routes, promotion of automated driving, program participants, and schedule • Agreement to continue cooperation with SIP-adus
9th OADF	March 6, 2018	Budapest, Hungary	• Presentation of the current situation of SIP-adus in concert with the report from European counterparts • Agreement to periodically share their nation's recent developments with respect to automated driving
10th OADF	July 20, 2018	Wuhan, China	• Presentation of the current situation of SIP-adus in concert with the report from European counterparts - Status of FOT (Field Operational Test) - Overview of The 2nd Phase of SIP-adus - Introduction of SIP-adus Work Shop 2018 scheduled to be held in November

4 Information Sharing with Industrial Sectors in Japan

For the purpose of sharing information among Japanese stakeholders and discussing the direction of standardization activities Japan should pursue, a conference called the Dynamic Map Standardizing Strategy Initiative was established. Members of the conference are composed of people from academia, the automobile industry and related fields.

Table 3 Dynamic Map Standardizing Strategy Initiative Schedule.

Conference	Date
1st Meeting	January 15, 2018
2nd Meeting	February 22, 2018
3rd Meeting	March 22, 2018
4th Meeting	June 20, 2018
5th Meeting	October 4, 2018

5 Conclusion

In order to contribute to the international community in the development of dynamic maps, a field expected to be integral to the automated driving system, this study investigated information such as details of the standardization documents and activities surrounding the formulation of industry specifications for dynamic maps. Furthermore, the investigation disseminated information regarding the current state of automated driving in Japan and sought out cooperative partnerships with appropriate organizations through participation in conferences like OADF and exchanges of information with relevant parties. For the purpose of sharing information among Japanese stakeholders and discussing the direction of standardization activities Japan should pursue, a conference called the Dynamic Map Standardizing Strategy Initiative was established. Members of the conference consist of people from academia, the automobile industry and related fields. SIP-adus will continue to seek out cooperative partnerships with appropriate organizations through participation in conferences like OADF, as well as the exchange of information with relevant parties.

References

(1) ITS Standardization 2017: Society of Automotive Engineers of Japan,
http://hq.jsae.or.jp/its/2017_bro_e.pdf (September 12, 2018)

International Standardization for Human Factor Issues in Automated Driving Systems

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

ABSTRACT: This article reviews ISO activities on human factors in automated driving systems. Human factors issues have been discussed in ISO TC22/SC39/WG8 (TICS on-board HMI) since 2014. Two technical reports have been published. One is for terms and definitions regarding human states and performance in the transition process. The other is for general ergonomic considerations for external HMI. Two other documents, consisting of experiment guidelines or considerations on human factor issues, are under discussion. An outline of those documents, and the contributions of the SIP-adus Human Factors and HMI research project, are also described here.

1 Discussions of Human Factors Issues in ISO Activities

International standardization activities regarding automated driving systems (ADS) have been conducted in ISO TC (technical committee) 22 and TC204. TC22 is the committee for road vehicles and TC204 is for intelligent transport systems. The main items to standardize in TC204 are the behavior of ADS, minimum functional requirements, minimum performance requirements and system testing procedures. In contrast, items covered in TC22 are more for elemental technologies, such as functional safety, design specifications, HMI/human factors, driver monitoring, event recording and component/subsystem verification. TC22/SC39/WG8 is a working group that addresses human factor issues in ADS.

The first meeting within TC22/SC39/WG8 regarding human factors in ADS was the Automated Vehicle Workshop during WG8 London meeting held in June in 2014. At that time, the SAE had already proposed the definitions for ADS levels, and VDA, Bosch, and BASt had also proposed separate, but similar, definitions. All the definitions were developed from the point of view of system functions (ability), rather than from a human-centered point of view.

During the workshop, we discussed what items should be standardized in terms of the human factor aspects of ADS. As ADS is a state of art technology, it proved difficult to reach a common agreement about target standards because the various ADS envisioned by researchers were all different. It was concluded that, in order to have a common understanding of ADS human factors issues, we needed to standardize terms/definitions and research protocols. In addition, we needed to clarify human-system interaction and system monitoring by the driver (user).

After the workshop, WG8 decided to establish a task force for ADS human factors (TF-ADS). The US delegates nominated Dr. Myra Blanco of VTTI as a candidate to lead TF-ADS. There was discussion in the national committee of Japan at the JSAE on how to deal with this matter. The committee concluded that we should step into the leadership role for ADS standardization in order to reflect the research outcomes of the SIP-adus project in international standards. Then, the Japanese committee nominated Dr. Ono of JARI (currently AIST) as a candidate to lead TF-ADS. In the end, WG8 agreed to make Drs. Myra and Ono co-leaders of TF-ADS at the Bron meeting held in November 2014. The TF-ADS activities then started in the WG8 Bron meeting. TF-ADS decided that the first document to establish as an ISO document would be a technical report with a list of ADS human factors-related terms and their definitions. The document was considered useful to achieve a common understanding of human factor issues in ADS.

2 ISO/TC22/SC39/WG8 Activities on ADS Human Factors

Since the Bron meeting in 2014, we have had two TF-ADS meetings every year. The TF-ADS members prepared materials for the terms related ADS human factor issues and their definitions in those meetings. The co-leader from the US changed from Dr. Blanco to Dr. Schaudt in 2017. After three years of discussions, the document was established as technical report TR21959 “Human Performance and State in the Context of Automated Driving: Part 1 – Terms and Definitions”. This document is now at the preparation for publication stage at the ISO secretariat.

During TF-ADS discussions before the Gothenburg meeting in May in 2017, we decided to prepare Part 2 of the “Human Performance and State in the Context of Automated Driving” document. The contents would be experiment guidelines to assess human factors in ADS. The aim of Part 2 was to include research finding and experiences obtained in the SIP-adus Human Factors and HMI research project. The proposal was approved as a new work item in the Orland meeting, and Dr. Kitazaki of AIST and Dr. Shaudt of VTTI were elected as co-leaders. The workshop for the experiment guidelines document was held in the Prague meeting in April 2018.

In the Paris meeting in November in 2016, Dr. Shutko of Ford, in the US proposed the establishment of a document for external HMI. He argued that automated vehicles would arrive soon and other road users would therefore need external HMI. These external HMI should be standardized in order to let those users understood the meaning of the HMI correctly. Then, the workshop was held at the Gothenburg meeting in June 2017. In the workshop, there were presentations, including one from the SIP-adus Human Factors and HMI research project, and discussions on the latest findings regarding external HMI. Since then, TF-external HMI has started its activities. There has been intense discussion in the TF that it is too early to establish the design guide because we still do not have enough scientific evidence to specify the external HMI design. Therefore, the first document should be a general ergonomic guide for considering external HMI. Also, the Japanese delegates offered the opinion that the first step should be to prepare a document for experiment guidelines to examine external HMI.

The followings sections introduce outlines of the documents under development in WG8.

3 TR21959: Human Performance and State in the Context of Automated Driving: Part 1 – Terms and Definitions(1)

3.1. Scope

The scope of the document is to cover basic terms and definitions related to driver performance and state in the context of automated driving. They are relevant to all levels of automated driving functions that require a human/ driver to be engaged or fallback-ready (SAE levels 1, 2 and 3). The terms are supposed to be used in human factors assessment/evaluations.

3.2. Transition process models

A process model of the transition from manual to automated driving, and a process model of the transition from automated to manual driving were proposed (Fig. 1). Terms related to takeover performance were defined in accordance with the models. “Significant driver intervention” is defined as an action initiated by the user of an automated driving system to request manual control. “Completion of driving manoeuver” is a takeover action expected of the driver to successfully handle the system limit. The time period until vehicle control performance is fully re-established after that completion is referred to as the “control stabilization phase”.

3.3. Performance measures in regaining control from automation.

Several variables can be used as measures of performance regarding interventions by the driver. They can be classified into two categories. One is “time-related performance measures” and the other is “quality-related measures”. “Takeover time”, “system deactivation time”, “intervention time” and “control stabilization time” are defined as time-related performance measures. “Safety-oriented objective takeover quality measures”, such as number of crashes, and “Sensitivity-oriented takeover quality measures”, such as standard deviation of lateral position of the subject vehicle, are examples of quality-related measures. In addition, expert assessments and subjective measures are included.

3.4. Measures of driver states

Attention, and the resources and tasks it demands, are defined as general terms. “Monitoring the driving environment”, “monitoring ADS performance”, “object and event detection and response (OEDR)”, “receptivity”, “situation awareness”, “vigilance”, “operating mode awareness”, and “operating state awareness” are defined as terms for driver states required for automation. OEDR and receptivity come from SAE J3016[2]. Measures for these states are described. Some other terms are referenced from SAE J3114[3].

Terms such as “visually distracted/loaded”, “visual-manually distracted/loaded”, “cognitively distracted/loaded” and “mind wandering” are listed for states corresponding to non-driving related activities. Terms, such as “hands on wheel”, “hand off wheel” and “foot position” are listed as driving position/ posture.

3.5. Driver readiness/availability

Readiness is a concept developed in the SIP-adus Human Factors and HMI research project. Availability is a similar concept developed in the KoHaf project in Germany. Therefore, a compromise to use both terms was reached, and they are defined as: the state of the driver during automated driving that influences successful driver intervention performance to regain control of the vehicle from the system to continue driving manually, avoid a hazard or bring the vehicle to a minimum risk condition. It is noted that readiness/availability is a concept and measures for it are to be developed.

3.6. Driver's experiences and attitudes regarding driving automation systems

As driver state and intervention performance depends on their understanding and behavioral attitude with respect to the use of the driving automation system, related terms are defined.

Prior knowledge of driving automation systems and prior expectations of driving automation systems are listed as terms for "prior system image". Knowledge of the system, functionality (purpose) of the system, functional limit and role of the user are listed as terms related to "education and training". Mental model, trust, overtrust, and trust calibration are listed as terms for "user understanding of driving automation systems". Acceptance, reliance, overreliance, underreliance, complacency, disuse, misuse and abuse are listed as terms for "user's use of driving automation system". The document provides definitions of these terms.

4 Road Vehicles: Human Performance and State in the Context of Automated Driving: Part 2 – Considerations in Designing Experiments to Investigate Transition Processes

Part 2 of the document is going to be prepared to help researchers when designing experiments to assess driver takeover performance. The title, structure and contents of Part 2 document are under discussion. Chapters that may be included are as follows. It should be noted that they are all tentative and subjects to change after discussion in the TF.

The chapter for "transition process model" describes the model that is relevant to this document. The "Human factors that influence takeover performance and methods to control/measure them in experiments" chapter will lists factors regarding human functions to be controlled or measured when conducting experiments. The "System factors that influence takeover performance" chapter will describe design elements of ADS to be specified when designing the experiment. The "Test scenario" chapter will describe how to design test scenarios. The "Takeover performance" chapter will describe performance measures collected to evaluate the system tested in the experiment. The "Testing environment" chapter will describe features, advantages and disadvantages of different types of testing conditions, such driving simulator, testing tracks and public roads.

5 TR23049 Road Vehicles -- Ergonomic Aspects of External Visual Communication from Automated Vehicles to Other Road Users[4]

This technical report describes basic ergonomic aspects to consider when designing and evaluating external HMI. This document focuses only on visual communication devices. There are eight chapters in the main body of the report.

The "Current road user communications" chapter describes communications that current road user performs. The "Potential ADS-DV communication" chapter lists possible communication contents of visual external HMI. They are vehicle state, such as vehicle speed and acceleration, and driving mode indicating that the vehicle is moving in automated mode. The "Vehicle perception" chapter explains that visual HMI should be perceived, recognized and understood. Also there is a possibility of presenting the state of the system in brief. The type of information conveyed will be "guidance information" such as prompting pedestrian(s) to start crossing the road and "intent information" such as the ADS-DV intends to stop at the crosswalk. The "Format of ADS-DV communication" chapter states that the format of the visual external HMI should be not confused with existing lighting. The chapter "Other considerations for ADS-DV communication", discusses the need to make compromises with existing laws. The "Acceptance of ADS-DVs by the public" chapter describes how trust is important for society to accept ADS-DV and how understanding the communication involved is necessary. Standardization can play a key role in that respect.

6 Conclusion

Human factors issues in ADS are a hot topic these days. When the ISO activities started in 2014, people were not aware of the importance of human factors in ADS. In this sense, WG8 made a good start. The SIP-adus Human Factors and HMI research project started in 2016 and has been able to make to important contributions to ISO activities. The current tasks in WG8 are all targeted at technical reports as ADS human factors are still under investigation. We should prepare to publish standards since they have a greater impact on society.

References

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(2) SAE J3016: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. 2016
(3) SAE J3114: Human Factors Definitions for Automated Driving and Related Research Topics. 2016
(4) ISO DTR23049 Road Vehicles -- Ergonomic Aspects of External Visual Communication from Automated Vehicles to Other Road Users.

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