Latest Development in SIP-Adus and Related Activities in Japan

Hajime Amano and Takahiko Uchimura

Abstract In 2014, Japanese government initiated a research and development program on connected and automated driving systems. Progresses made in the first half of this 5-year program are described in this paper. For the second half of the program, large-scale field operation tests are being planned. Objectives, scope and opportunities for international participants during the field operation tests are introduced. Expected applications of connected and automated driving technologies to overcome societal challenges in the Japanese context, such as aging and declining population, are also described.

Keywords Automated driving · Dynamic map · Connected vehicles · Human factors · Field operation test · Inclusive society

1 Overview of the SIP-Adus Program

Japanese national program on connected and automated driving systems started in 2014. The program name, SIP-adus, stands for Cross-Ministerial Strategic Innovation Promotion Program, Innovation of Automated Driving for Universal Services.

Connected and automated driving will be realized integrating a variety of technologies. On-board technologies are already in product level competition. Auto manufacturers are demonstrating their technologies and announcing near future products. Therefore, scope of SIP-adus, as a government funded project, does not include on-board technologies nor development of prototype automated cars.

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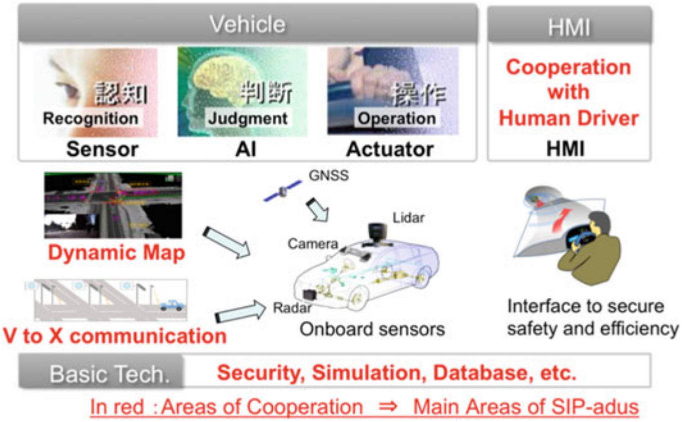

Fig. 1 Technologies for connected and automated driving

The program is focusing on platforms to be shared among stakeholders. Those are Dynamic Map, Connected Vehicles, Human Factors, Impact Assessment, Next Generation Transport and Cyber-security (see Fig. 1). Under the SIP-adus, more than 20 research projects are being conducted. Integrating results from those projects with active participation of auto manufacturers and research institutes, a large-scale field operation tests will be conducted from September 2017 through March 2018 (Morishita 2016; Kuzumaki 2016).

2 Progress of SIP-Adus in the Focus Areas

2.1 Dynamic Map

The Dynamic Map is composed of layers with different time frame; static, semi-static, semi-dynamic and dynamic. SIP-adus developed a prototype of the static database of the Dynamic Map and the location-referencing framework for dynamic data was also developed.

On a screen capture of the Dynamic Map viewer to evaluate the database and the location referencing, three-dimensional model of the road environment is shown over the measured data (see Fig. 2). Dynamic data of other road users, such as cars and pedestrians, are shown as yellow symbols.

It is emphasized that combination of cooperation to build shared common database and competition in the service operations with additional proprietary data. Based on the achievement through the SIP-adus, a company named ‘Dynamic Map Planning’ was founded to create a business model in line with the concept of balancing cooperation and competition. Survey companies, digital map

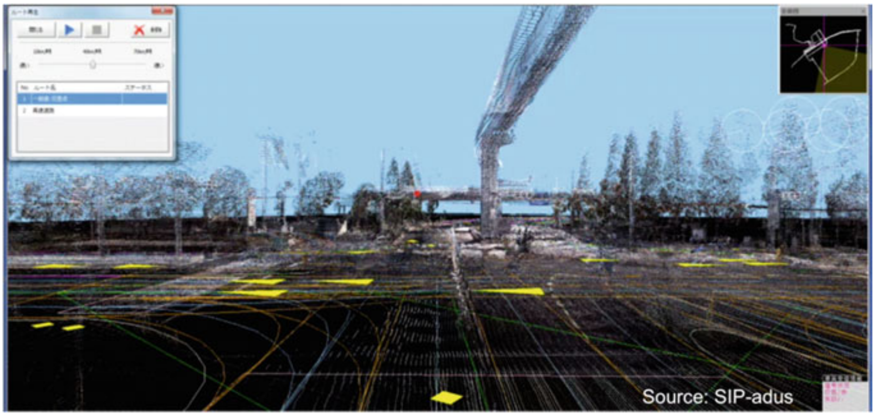

Fig. 2 Prototype dynamic map—viewer

suppliers and 9 Japanese major auto manufacturers joined. Targeting 2017, this company will be transformed into a real business entity (Shirato 2016).

2.2 Connected Vehicles

Evolution of connected and automated vehicles will be realized by integrating built-in features of driving assistance, getting more and more popular in the market, and cooperative systems, already in nationwide operation for more than 6 years in Japan. In other words, cooperative system is an essential part of the automated driving. Examples of connected services recently deployed are described in this section.

The Traffic Signal Prediction Systems or TSPS is a good example to mitigate traffic congestion at signalized intersections. Phase and timing of traffic signals are broadcast at the intersections. On-board system judges safe and most efficient speed and acceleration or deceleration timing (see Fig. 3). The system has already been installed and used by manually driven cars. 5–9% reduction of waiting time at red signal and about 10% reduction of fuel consumption are observed.

Today, more than 90% of highway toll is electronically collected in Japan after 15 years of operation. Using the same spectrum, nationwide deployment of road-side equipment for cooperative services was completed 6 years ago at 1600 locations. Safe driving assistance, traffic information provision and dynamic route guidance are available. The new services such as dynamic toll charging to guide drivers to less congested route with lower toll incentive, and freight operator support, utilizing probe data from the trucks are expected to start soon (Amano 2016).

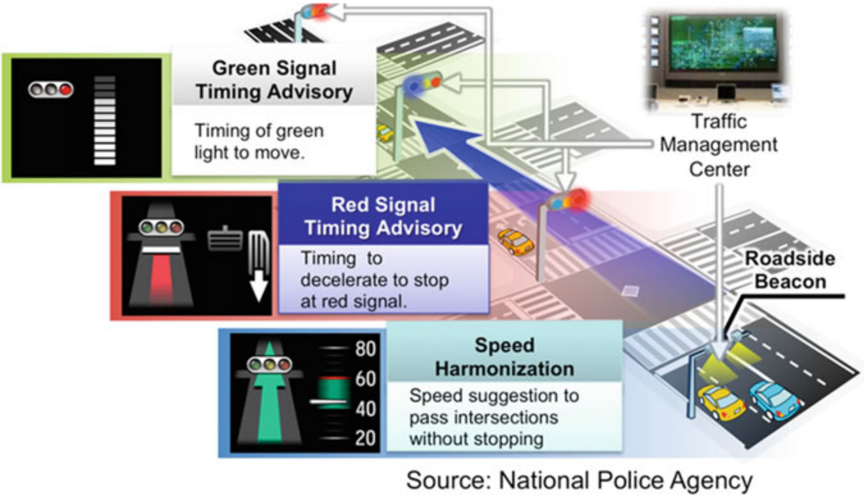

Fig. 3 Traffic signal prediction systems (TSPS)

2.3 *Human Factors*

Human factors are also important area. At SIP-adus, for the first phase, the focus of attention was transitions of roles between vehicle control system and human driver. Important cases are identified and a series of events, which trigger transition, are being analyzed along the timeline in each case. Then, the scope has been extended to cover the interactions between automated vehicles and surrounding road users and the society. Categories of issues on Human Factors are shown in Table 1 (Kitazaki 2016).

2.4 *Next Generation Transport*

Applications of automated driving technologies to public transportation is investigated at SIP-adus. The Advanced Rapid Transit will be deployed for the Tokyo Olympic and Paralympic Games in 2020. Tokyo Metropolitan Government and Keisei Bus Co., Ltd. released a Bus Rapid Transit deployment plan, including the ART system, in the waterfront area, where facilities for the Olympic and Paralympic Games are located. Keisei Bus is the operator of the system. The operation will start in 2019 (Amano 2016).

Table 1 Human factors—categories of issues

Interaction between	System use	
Vehicle–driver	A-1	Understanding system functions
	A-2	Understanding system states
	A-3	Understanding system operations
	A-4	Understanding system behavior
	Driver's state	
	B-1	Driver state with automation
	B-2	Transition from automation to fully manual
	B-3	User benefits of automation
Vehicle–surrounding road users	C-1	Communication between the autonomous vehicles and surrounding drivers
	C-2	Communication between the autonomous vehicle and surrounding vulnerable road users
	C-3	Mediation between formal rules and traffic efficiency
Vehicle–society	D-1	Social value and acceptance of the autonomous vehicles
	D-2	Liability
	D-3	Licensing

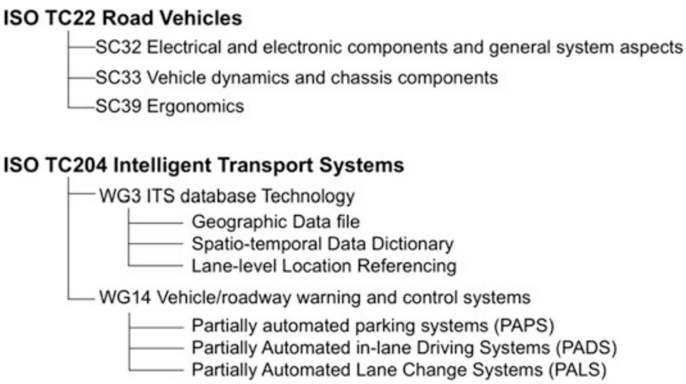

Fig. 4 Standardization at ISO

2.5 Standardization

Results of SIP-adus activities are input to the international standardization body (see Fig. 4). At ISO TC204 and TC22, Dynamic Map, system design and human factors are actively discussed. SIP-adus with other related activities in Japan is one of the contributors to those discussions (Shibata 2016; Uchimura 2016).

3 Large-Scale Field Operation Tests as a Platform for International Cooperation

Large-scale field operation tests are planned under SIP-adus program starting September 2017 through March 2018. Outline of the field evaluation tests is described in this section. Participation to the field operation tests is open to any qualified organizations. International participation is also welcome (Minakata 2016).

3.1 Objectives

The expected outcome the field evaluation tests is to provide auto manufacturers and research institutes with internationally shared platform to devise harmonized specifications and framework for connected and automated vehicles deployment, with active participation of international stakeholders.

Both technological excellence and harmonization in technical specifications are important aspects of the field operation tests. In addition, it is also recognized that feasibility and sustainability of practical operations should be taken into account.

3.2 Outline of the Field Operation Tests

3.2.1 Focus Areas

More than 20 projects are being conducted under SIP-adus. Achievements from those projects are integrated into 5 focused themes of test operations.

Those are:

- *Dynamic Map*: Prototype Dynamic Map of 3-dimensional high-resolution digital map data with road geometry and surrounding structures is evaluated. Semi-dynamic information such as traffic congestion and road closure is also included. Prototype data exchange scheme for generating, maintaining and distributing Dynamic Map is evaluated, too.
- *Human Machine Interface*: Drivers' understanding of the operational status of automated vehicles, readiness of the driver to take over the control of the vehicle under a variety of scenarios are measured and evaluated. Means of interactions of the automated vehicle with other road users are also investigated.
- *Information security*: Vulnerability against a variety of simulated cyber attacks is evaluated in a closed test environment. Counter measures are also evaluated.

Fig. 5 Field operation test site

- *Pedestrian accident reduction*: Applications of vehicle to pedestrian communication technologies to prevent cognitive mistakes and remind potential dangers are evaluated.
- *Next generation urban transportation*: Advanced Rapid Transit system with connected and automated technologies is evaluated from service level point of view for challenged passengers.

Demonstration of the connected and automated vehicles is also planned to promote proper understanding of new technologies for the general public, fostering social acceptance of deployment of those systems.

3.2.2 Test Sites

Three types of test environment are assigned. About 300 km stretches of expressways are selected surrounding Tokyo Metropolitan area, including Joban expressway, Tokyo Metropolitan expressway, Tomei expressway and Shin-Tomei expressway. For arterial road testing, Tokyo waterfront area is selected, where major facilities of Tokyo Olympic and Paralympic Games are located. In addition, for controlled environment testing, test facilities at Japan Automobile Research Institute will be used (see Fig. 5).

3.2.3 Resources

SIP-adus program will make all the arrangement among related national and local government agencies and road operators for the participating parties to use those test sites. Overall management of the field evaluation tests is also under the SIP-adus program. Shared databases essential for the objectives to be fulfilled, such as Dynamic Map for the entire test sites, will be built and distributed to the participating parties including follow up access to the updates for free. However, vehicles, drivers, supporting staff for safety of the vehicles and other road users, and necessary insurance coverage must be provided by the participating parties at their own cost.

3.2.4 Regulations

Test vehicles must comply with the Safety Regulations for Road Vehicles under the Road Traffic Act. Operation of the test vehicles must follow Road Traffic Act. The human driver monitors the surrounding traffic and the vehicle's condition at all times. In the event of an emergency, the driver operates the vehicle as necessary. In addition, the National Police Agency released Guidelines for Public Road Testing of Automated Driving Systems in May 2016. Participating parties are required to follow the guidelines.

3.3 Opportunities and Requirements for Open Participants

In the light of the objectives of the field operation tests, participation to the field operation tests is open to any auto manufacturers and research institutes as long as they meet the regulations and arrange necessary resources by themselves. Because it is important for the international players to work together to develop harmonized technical specifications and feasible operational framework, all the participating parties are required to submit test reports according to the guidelines set by SIP-adus. However, any proprietary data related to on-board technologies are not required to share. Only generic information to enhance technical specifications of common platforms and practical feasibility of deployment will be required.

4 Societal Values to Be Created with Connected and Automated Vehicle Technologies

4.1 Challenges for the Japanese Society

The key message from SIP-adus is 'Mobility Bringing Everyone a Smile'. We envision an inclusive society, where connected and automated driving technologies provide everyone with mobility to fully exercise his or her capacity, enabling sustainable development of the society (Amano 2016).

Fig. 6 Cluster of villages

4.2 Mobility for Enhanced Quality of Life and Socio-economic Activities

In 2014, Japanese government compiled a Grand Design towards 2050, where three types of cities are defined. In rural areas where most serious population decline is projected, small villages are connected to a basic social service hub with transportation and information network to maintain combined population of 10,000. We will have 5000 clusters of this kind (see Fig. 6).

Middle size cities are integrated to have combined population of at least 300,000, connecting to each other within one hour of travel. Population of 300,000 is necessary to maintain high-level education, medical care and employment opportunities. We will have 60–70 of reginal hubs (see Fig. 7).

Mega-cities like Tokyo become more concentrated center for competitive edge in global economy. Industries across the country are integrated by high capacity and efficient transportation for both people and goods and connected to the global operations. For the Japanese society to be sustainable, comprehensive transportation network is essential. For the transportation to be sustainable, innovative technologies such as connected and automated systems and social innovations are essential.

SIP-adus is expected to significantly contribute for the Japanese Society to overcome those challenges.

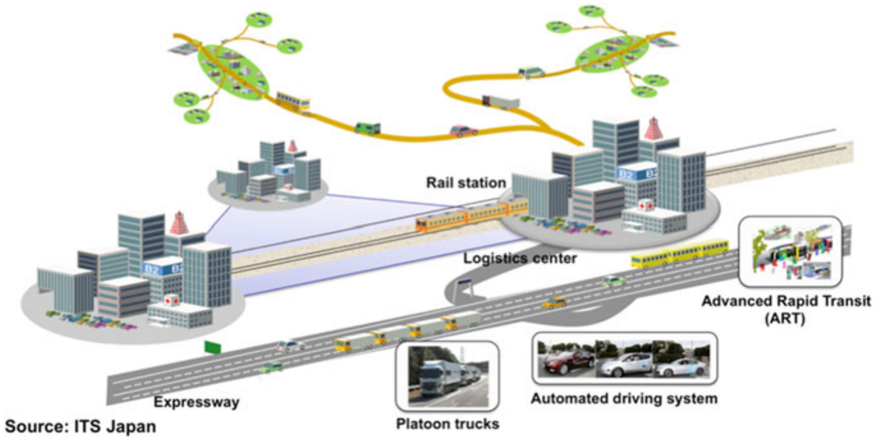

Fig. 7 Integrated regional hub

5 Conclusion

SIP-adus is a 5-year research program on connected and automated driving. Since it started in 2014, a variety of achievements have been made in more than 20 projects. Those results are integrated and evaluated through a large-scale field operation tests from September 2017 to March 2018. The field operation tests are designed to be an internationally shared platform to devise harmonized specifications and framework for connected and automated vehicle operations. It is anticipated that outcome of SIP-adus will create an inclusive society with enhanced mobility and it is disseminated to the other part of the world.

References

Amano H (2016) Latest development in SIP-adus and related activities in Japan. Automated vehicle symposium, San Francisco

Kitazaki S (2016) SIP-adus human factors and HMI research, SIP-adus Workshop, Tokyo

Kuzumaki S (2016) SIP automated driving systems—mobility bringing everyone a smile. Keynote, SIP-adus Workshop, Tokyo

Minakata M (2016) The outline of SIP-adus FOT, SIP-adus Workshop, Tokyo

Morishita S (2016) Japanese coordinated approach for R&D of automated driving system—cross-ministerial strategic innovation promotion program (SIP). PL1, ITS World Congress Melbourne

Shibata J (2016) Development of dynamic map in SIP-adus, SIS36, ITS European Congress in Glasgow

Shirato R (2016) Dynamic map development in SIP-adus, SIP-adus Workshop, Tokyo

Uchimura T (2016) SIP-adus update, SIS 39, ITS World Congress Melbourne