INTELLIGENT TRANSPORT SYSTEMS

1 Introduction

Intelligent transport systems (ITS) have been developed to help resolve various social issues through the adoption of innovative technologies. Examples of these issues include traffic accidents, congestion, and the increasing burden placed on the environment by emissions. Information and communication technology used to connect vehicles with roadside infrastructure, other vehicles, pedestrians, and motorcycles has become more widely adopted, and the scope of its contribution has been expanding.

Following the June 2013 Cabinet approval Declaration to be the World's Most Advanced IT Nation[1], the subcommittee for road traffic was established under the New Strategies Promotion Expert Committee and, focusing on driving safety support and automated driving systems and on the use of traffic data discussed the Public-Private ITS Initiatives/Roadmaps, which was approved by the IT Strategic Headquarters on June 3, 2014.

The document outlines the general principles and lays out a concrete roadmap for initiatives that require close collaboration between the public and private sectors, to achieve the goal of building and maintaining the world's most advanced ITS, as well as contributing to society in Japan and the world. It also establishes the basis for ongoing discussions, in 2014 and thereafter, of both society-oriented metrics such as reducing traffic accidents, alleviating congestion, and supporting the mobility of the elderly and the industry-oriented metrics of propagating automated driving systems, vehicle production and exports, and exporting infrastructure, each viewed from the perspective of attaining and maintaining the position of best in the world. The roadmap also defines different levels for automated driving systems, which are currently the object of worldwide research and debate, and for driving safety support systems, and sets expected time frames for commercializing such systems.

The revised Public-Private ITS Initiatives/Roadmaps 2015 presents (a) automated driving systems that contribute to strengthening competitiveness in the global market, (b) regional public transportation systems featuring automated driving functionality and, (c) compact automated driving systems for local communities, as specific examples of systems that should be targeted in terms of development and dissemination in the short term. Explicit strategies regarding the application of traffic data included (a) more advanced maps and the overlaying of various data, (b) the application of probe data and vehicle-related information and, (c) the utilization of traffic and other big data in various policies and measures, as initiatives to be pursued at present while formulating a basic policy addressing changes in data flow structures.

The subsequent Public-Private ITS Initiatives/Roadmaps 2016 added new definitions for semi-autopilot and autopilot automated driving on highways, as well as unmanned automated driving mobility services, and presented a clear process chart and list of specific issues to assess to realize these technologies by 2020.

This was followed by a reorganization and consolidation of the various subcommittees established under the New Strategies Promotion Expert Committee, including the subcommittee for road traffic, into a subcommittee on data utilization architecture and problem resolution, and discussion of the Public-Private ITS Initiatives/Roadmaps were moved to the Road Transport Working Team established under this new subcommittee.

The discussions of this working group for road traffic centered around addressing the international spread of the Society of Automotive Engineers (SAE) definitions of automated driving levels since the autumn of 2016 and the growing importance of setting up a data architecture to realize automated driving (e.g. creating driving image databases to improve the capabilities of artificial intelligence (AI) and commercializing, increasing the sophistication of, and establishing a communication infrastructure for, dynamic maps). The Public-Private ITS Initiatives/Roadmaps[2] which summarizes the outcomes of those discussions was finalized at the sixth Road Transport Working Team meeting on May 18, 2017 and, following deliberation at the subcommittee on data utilization architecture and problem resolution and the New Strategies Promotion Expert Committee, was approved by the IT Strategic Headquarters on May 30, 2017.

The establishment of the frameworks required to allow marketing and services related to level 3 automated driving systems was discussed by a sub-working team for the improvement of the legal system and environment for automated driving created under the working team for road traffic. Over five discussion sessions, the team formulated the Charter for Improvement of Legal System and Environment for Automated Driving Systems, in which (a) in the area of vehicle safety, formulating guidelines on safety requirements for autonomous vehicles by the summer of 2018, (b) in the area of road traffic regulations, initiate the discussions necessary to make prompt amendments in line with international agreements and, (c) clearly define responsibilities in the unlikely event of an accident by taking advantage of the existing Automobile Accident Compensation Act, and making the prompt rescue of victims possible, as well as evaluating the mandatory installation of drive recorders, as courses of action.

2 ITS Trends in Japan

2. 1. VICS[3]

VICS is an information and communication system that transmits the road traffic information compiled and processed at the Vehicle Information and Communication System Center using the three types of communication describe below, for display in three forms (text, simple graphics, and maps) on navigation systems and other onboard devices.

2. 1. 1. FM Multiplex Broadcasting

Regional NHK and FM broadcasters provide traffic information for roads in and around their respective prefectures (congestion or travel times, traffic restrictions due to accidents, disabled vehicles, roadwork, natural disasters, or weather conditions, as well as information on parking locations and the availability of spaces there).

2. 1. 2. Radio beacons

These beacons are set along roads and provide traffic information within approximately 1,000 km ahead of the vehicle (travel time between interchanges, congestion, guidance at junctions, and traffic restrictions due to accidents, disabled vehicles, roadwork, natural disasters, or weather conditions).

2. 1. 3. Infrared beacons

These beacons are mainly set along ordinary roads and provide traffic information within approximately 30 km ahead of, and 1 km behind the vehicle (congestion or travel times, traffic restrictions due to accidents, disabled vehicles, roadwork, natural disasters, or weather conditions, as well as information on parking locations and the availability of spaces there).

As shown above, VICS provides various information, including travel times, congestion statuses, and traffic restrictions to navigation systems in real-time, offering greater driver convenience as well as contributing to smoothing traffic streams and improving fuel efficiency through appropriate route guidance.

Furthermore, the new VICS WIDE system launched in April 2015 offers route guidance with high-precision avoidance of congestion based on travel times provided by links on ordinary roads, more detailed traffic information relying on probe data, pop-up advisories for all special weather, tsunami, or volcanic eruption warnings, and information on areas struck by heavy rains.

2. 2. UTMS[4]

The aim of the Universal Traffic Management System (UTMS) is the realization of a safe and comfortable traffic environment with a low environmental load. It achieves this through sophisticated use of information communication technology, including two-way communication between individual vehicles and traffic management systems using infrared beacons. This enhances the safety and smooth flow of road traffic, and also alleviates traffic pollution.

2. 2. 1. Promotion of UTMS

The main applications of UTMS as of the end of the 2016 fiscal year are as follows.

- Advanced Mobile Information Systems (AMIS)

AMIS are systems that aim to naturally disperse of traffic streams and alleviate congestion by complementing information from sources such as traffic information signs and radio broadcasts with traffic information sent to onboard devices via infrared beacons. As of the end of 2016, all prefectures in Japan had adopted AMIS.

- Fast Emergency Vehicle Preemption Systems (FAST)

These systems use infra-red beacons to detect emergency vehicles in areas where call outs are frequent and control traffic signals to give priority to those vehicles. The aim of FAST is to shorten the time required for emergency vehicles to reach an incident scene or medical facility and to help prevent traffic accidents involving emergency vehicles. As of the end of 2016, 16 prefectures had adopted FAST.

- Public Transportation Priority Systems (PTPS)

PTPS control traffic signals to give priority to buses and other public transportation. The system aims to reduce journey times and increase user convenience. As of the end of 2016, 41 prefectures had adopted FAST.

- Traffic Signal Prediction Systems (TSPS)

TSPS aim to reduce driving stress and prevent traffic accidents due to sudden braking and sudden starts by providing advance information such as what color the signal will be when drivers reach a signalized intersection. As of the end of 2016, 26 prefectures had adopted FAST.

- Pedestrian Information and Communication Systems (PICS)

Aiming to support the safety of pedestrians, (particularly the elderly and people with visual impairment), this system uses approaches such as audio notification of traffic signal states and extending the duration of green lights to prevent accidents. As of the end of 2016, 33 prefectures had adopted PICS.

2. 2. 2. Initiatives for the Practical Application and Enhancement of Infrastructure-Vehicle Cooperative Driving Safety Support Systems (DSSS)

These systems aim to prevent traffic accidents and otherwise enhance road safety by providing drivers with visual and auditory information on surrounding traffic conditions, alerting them to potential dangers and creating an environment that reduces driving stress.

In 2014, a research study on reducing infrastructure costs for DSSS using radio waves to prevent right-turn collisions and failures to notice crossing pedestrians or red lights at intersections was conducted, and test course functional validation of those DSSS was carried out in 2015. In 2016, a research study on the collection of information required when traveling straight or turning left, as well as the possibility of detecting moving objects other than vehicles or pedestrians, was undertaken to further enhance these systems, and a model system for the collection of information required for left turns was prepared.

2. 2. 3. Enhancement of Traffic Control Information Using Probe Data

Information from existing roadside sensors was combined with probe data (vehicle driving history information stored in onboard devices) to build a more detailed traffic signal control system based on extensive traffic information in an effort to smooth traffic flow. In 2017, the system was installed in 8 prefectures in conjunction with updates to the central units in the traffic management centers.

2. 2. 4. Creation of a Traffic Information Service Environment for Disasters Using Probe Data

In the event of a disaster, traffic data collected from existing information gathering devices will be combined with police and private sector probe data to promptly identify usable roads. Such information will not only be passed on to the local population, but also prove useful for police activities on-site (setting extraordinary traffic restrictions or securing emergency routes). In 2017, the system was installed in 7 prefectures in conjunction with updates to the central units in the traffic management centers.

2. 2. 5. Deployment to Next-Generation Urban Transportation

Enhanced PTPS with functions such as the use of radio waves to detect bus position and the provision of traffic signal information to buses, as well as enhanced PICS that use mobile phones to provide audio notification of traffic signal states to pedestrians, or extend the duration of green lights, are being developed to enable a safe and smooth flow of traffic in preparation for the realization of next-generation urban transportation for the Tokyo Olympic and Paralympic Games in 2010 and its subsequent deployment to other regions. For enhanced PTPS, the basic design for demonstration tests was established in 2015, a model system prepared in 2016, and the effectiveness of the model system was validated in 2017. For enhanced PICS, the basic design for demonstration tests was established in 2015, with the building and validation of the effectiveness of the model system carried out in 2016 and 2017, respectively.

2. 3. Smartway

The aim of the Smartway Project is to enhance traffic safety and to develop measures for improving congestion and the environment. In this project, a Smartway is defined as a next-generation road that uses ITS technology to link people, vehicles, and roads by information. Since the announcement of ITS, Second Stage in August 2004, government, industry and academia have worked in concert and, following the research, development, and field testing of new infrastructure-vehicle cooperative systems, launched ITS spot services, primarily offered along expressways nationwide, in August 2011. These services were renamed ETC 2.0 in October 2014, with full-scale sales of ETC 2.0 on-board units beginning in August 2015, and the introduction of services that capitalize on route information is under consideration.

2. 3. 1. Extensive and Effective Provision of Road Traffic Data

The number of vehicle navigation systems in Japan exceeded roughly 80.91 million units at the end of December 2017. Of these, approximately 57.70 million are compatible with real-time VICS road traffic information (services started in 1996) (Fig. 1). VICS provides various information, including travel times, congestion statuses, and traffic restrictions to navigation systems in real-time for greater driver convenience. Appropriate route guidance from VICS is also effective in reducing CO_2 emissions and the burden on the environment by smoothing traffic streams and improving fuel efficiency. As a result, VICS helped reduce CO_2 emissions in 2012 by roughly 3.2 million tons.

2. 3. 2. Propagation and Effectiveness of ETC

ETC has gained widespread acceptance since its full-scale introduction of in March 2001. As of the end of December 2017, over 78.9 million onboard units had been set up, and 24 nationwide expressway and public road management companies use a single nationwide ETC system, which has a utilization rate of roughly 90%. ETC has virtually eliminated congestion at toll booths, which accounted for about 30% of expressway congestion throughout Japan. Consequently, ETC also helps lower the burden on the environment by reducing CO_2 emissions.

2. 3. 3. Nationwide Spread of ETC 2.0 Services

2. 3. 3. 1. Start of ETC 2.0 Services

The Ministry of Land, Infrastructure Transport and Tourism (MLIT) set roadside devices at roughly 10 to 15 km intervals on inter-city expressways, and at roughly 4 km intervals on inner city expressways, and launched the world's first infrastructure-vehicle cooperative ITS spot service in August 2011 (by the end of December 2016, roadside units had been set at approximately 1,700 locations along expressways throughout Japan).

In addition to ETC and services providing congestion avoidance support and driving safety support information, the roadside devices are used to collect probe data. The name of the services was changed from ITS spot services to ETC 2.0 in October 2014, and the introduction of services making use of route data, as well as a well-rounded lineup of private services, are being promoted. Regular sales of onboard ETC 2.0 devices began in August 2015, and as of the end of December 2017, the number of new ETC 2.0 onboard unit installations had reached a cumulative total of approximately 2,350,000.

2. 3. 3. 2. Progress of Awareness Activities Related to Further Popularization

Expositions held in or after October 2017 such as the ITS World Congress in Montreal, CEATEC Japan 2017, and the 2017 Tokyo Motor Show featured booths to increase awareness of ETC 2.0 services. The booths included panels and videos presenting initiatives that make wise use of those services, as well as, in cooperation with the manufacturers, exhibits of ETC 2.0 onboard units and compatible navigation systems. In addition, proactive initiatives to promote greater implementation of these services at nationwide *michi no eki* roadside stations, as well as expressway parking and service areas were carried out.

2. 3. 3. 3. Initiatives in the Fields of Transportation and Logistics

Although the use of ETC in the fields of transportation and logistics has been limited to the payment of tolls, initiatives to optimize transport by truck via the application of data on routes traveled and usage times collected with ETC 2.0 are being promoted.

・Streamlining of passage permits for ETC 2.0-equipped special vehicles

Under the current system, special vehicles can only travel on routes for which individual applications have been submitted. Not only does this burden applicants for special vehicle permits with cumbersome application paperwork for each route, it also requires following renewal procedures every two years.

Since the route used by ETC 2.0-equipped vehicles can be identified, a free choice of routes is permitted for vehicles traveling on roads designated as sections allowing the passage of heavy-duty vehicle by the national government. This initiative will enable special vehicles to use an alternative route to avoid congestion or accidents, making more efficient transport possible. At the same time, the biannual renewal for vehicles following the application procedure for passage will be made automatic. These streamlining initiatives started in January 2016.

- ETC 2.0 support services for truck operations management

ETC 2.0 allows real-time acquisition of data such as routes traveled, usage times, or acceleration and deceleration. Allowing transportation and logistics operations to make use of that information would enable operations management that leads to greater productivity by reducing delivery wait times through accurate prediction of arrival times, as well as make drivers safer through pinpoint identification of dangerous truck driving locations.

The first stage of applications for participation in support services for truck operations management using ETC 2.0 opened in November 2015, and tests started in February 2016, followed by a second of applications for participation in September 2016. Effects such as the reduction of delivery wait times were evaluated between then and 2017. Full-scale introduction of the service is scheduled for 2018.

2. 4. Advanced Safety Vehicles (ASVs)[6]

Since 1991, the Road Bureau of MLIT has promoted the development, commercialization and popularization of ASVs through coordination between government, industry, and academia. In accordance with the sixth phase of the Advanced Safety Vehicle Project, the study of various advanced safety technologies necessary to achieve automated driving, including an extensive popularization strategy for already commercialized ASV technologies and of technical requirements for driver emergency response systems expanded to pull over on the road shoulder continued in 2017. Technical requirements for highways were defined for driver emergency response systems expanded to pull over on the road shoulder and a basic design document (guideline) was issued on March 29, 2018.

In addition, the ASV Project continues to play a supporting role for the commercialized advanced safety technologies it promotes (such as collision damage mitigation brakes, lane departure warning systems, and vehicle stability control systems).

2. 5. Automated Driving Systems

The Comprehensive Strategy on Science, Technology and Innovation 2017[7], finalized by the Cabinet as a document indicating issues to emphasize during individual fiscal years based on the mid- to long-term direction stipulated in the basic plan for science and technology while keeping an eye on new initiatives and changes, presents issues such as the positioning of research and development on automated driving systems as a core initiative to achieve proper cyber-physical systems for the realization of Society 5.0, as well as the development of dynamic maps, as matters calling for active promotion. With respect to the realization of a sustainable society adapted to super aging and population decline, intelligent transportation systems were identified as a crucial issue, raising (1) focused efforts on critical issues related to the development of automated driving systems, (2) the promotion of large-scale demonstration tests for automated driving systems, (3) initiatives aimed at Society 5.0, (4) the development, validation, practical installation, and establishment of business models for peripheral technologies and systems that support automated driving systems and, (5) identifying the main initiatives targeting social implementation and, on a national level, prioritizing the promotion of initiatives to develop, promote the commercialization and standardization of, and create new industries for element and practical technologies considered part of the areas of cooperation, as specific initiatives.

This comprehensive strategy, and the Japan Revitalization Strategy approved by the Cabinet in June 2013[8] established the Strategic Innovation Promotion Program (SIP)[9] to enable the Council for Science, Technology and Innovation to fulfill its role as a control center and realize scientific and technological innovation.

In 2016, the Council for Science, Technology and Innovation appointed Seigo Kuzumaki of Toyota Motor Corporation as the leader (Program Director) promoting the research and development of the automated driving systems on which SIP has been working since June 2014. Since 2016, research and development has centered on the five technological areas of dynamic maps, HMI, information security, reducing pedestrian accidents, and next-generation urban traffic, which represent areas of cooperation that should involve joint government-industry-academia efforts to reduce traffic accidents through the early practical application and propagation of automated driving systems as well as to realize next-generation urban traffic systems.

In preparation for further enhancement and deployment after SIP comes to an end, 2017 was defined as a period of completion leading to unequivocal practical application and commercialization of the outcomes of research and development until then, and efforts were primarily directed at the four fields of (a) promoting research and development centered on large-scale demonstration tests, (b) commercialization and the building of business models, (c) regional deployment and government-industry-academia collaboration and, (d) international collaboration and standardization activities.

Specifically, large-scale demonstration tests involving the participation of over 20 automakers and other organizations in and outside Japan were conducted on the Tomei Expressway, Shin-Tomei Expressway, Metropolitan Expressway and Tokiwa Expressway, as well as on ordinary roads in the Tokyo Rinkai area. The large-scale demonstration test provided an open forum to have the many eyes of the numerous participating automakers and organizations make an evaluation of the outcome of the research and development conducted since 2014 centering on the five important topics, as well as to promote international collaboration and standardization thanks to the involvement of non-Japanese manufacturers.

In November 2017, the SIP-adus Workshop 2017 international conference was held to discuss automated driving system issues and their solutions with the involvement of international leading experts in the various topics of research in anticipation of the realization of advanced automated driving systems. This Workshop has gained international recognition as one of the main conferences on automated driving. The 2017 Workshop was attended by nearly 500 experts from outside Japan, including high-ranking members of the U.S. Department of Transportation and European Commission executives and presented the latest automated driving system initiatives from around the world.

In February 2015, the heads of the Manufacturing Industries Bureau of the Ministry of Economy, Trade and Industry and the Road Bureau of the Ministry of Land, Infrastructure Transport and Tourism jointly established the Panel on Business Strategy of Automated Driving to establish the entire Japanese automotive industry, including suppliers, as a global leader in the field of automated driving, as well as to proactively work on reducing traffic accident fatalities and contribute solutions to other social issues(10).

The panel identified (a) clarified the future vision of automated driving for ordinary cars, (b) identified, intensified and expanded areas requiring cooperation, (c) established a framework to strategically respond to the creation of international rules (criteria and standards), (d) discussed the promotion of industry-academia coordination, as initiatives requiring nationwide government-industry-academia examination and compiled the Action Plan for Realizing Automated Driving, Version 2.0 (March 2018). That policy is outlined below.

- Future vision of automated driving (levels 2, 3 and 4) for ordinary cars

The assessment was divided into private cars, for which driving areas and methods can be left up to the driver, and business use vehicles, for which companies could control driving conditions, such as imposing low-speed driving in limited road sections.

Private use

Achieve level 2 on highways by 2020, and gradually introduce the systems on ordinary roads, starting with main national roads, thereafter. Start introducing higher levels of automated driving around 2025. *The feasibility and timing of levels 3 and higher will require further legal and technical discussions, and only presented as a general guide.

Business use

Achieve level 4 in some regions around 2020 and gradually expand covered areas.

Implement and commercially use simple scenarios while complementing technology with the legislation and infrastructure, gradually expanding to more complex scenarios with the aim of staying at the global leading edge.

ISO/TC204 (Intelligent transport systems) has been working on international standards for the fundamental basic technologies in automated driving systems. Japan has played a leading role by, for example, obtaining the position of convener for WG3 (Maps) and WG14 (Vehicle/Roadway Warning and Control Systems). However, with standardization efforts aimed at the early adoption of automated driving systems gaining momentum in the U.S. and Europe, jockeying to take the lead in international standardization efforts is expected to intensify.

Consequently, based on the progress of regional standards in the U.S. and Europe, and while keeping global interoperability in mind, METI has supported the preparation of a draft of international standards for performance requirements as well as international standardization activities (in response to ISO/TC204 (ITS)) concerning advanced driving support systems and related systems such as dynamic maps and vehicle control systems.

Demonstration tests of *michi no eki* roadside station-based automated driving services in semi-mountainous regions have also begun. Such regions have an aging population, and the transportation of people and goods in everyday life is becoming an urgent problem.

At the same time, approximately 80% of the 1,134 *michi no eki* roadside stations throughout Japan are found in semi-mountainous regions, providing goods for sales as well as acting as clinics and offering administrative and other everyday life services.

Setting such *michi no eki* as regional hubs and capitalizing on the autonomous vehicles showing remarkable technological evolution would

1) ensure day-to-day life mobility for the elderly for shopping or traveling to and from the hospital,
2) secure logistics services such as home deliveries and the shipping of agricultural products,
3) be useful for sightseeing and the creation of new workplaces.

Other initiatives to carry out demonstration tests aimed at building vehicle-to-infrastructure transportation systems to maintain local lifestyles and revitalize the regions are also underway.

The 2017 demonstration tests were conducted at thirteen locations throughout Japan and assessed vehicle and road technical issues such as effects on road structure and traffic, or weather conditions, as well as business models such as consolidated passenger and freight services.

Through SIP, the Ministry of Internal Affairs and Communications (MIC) is promoting the development of technology to enhance the safety of automated driving through wireless systems.

Specifically, in the context of the Next-Generation ITS utilizing ICT project, further technological development and demonstration tests are being conducted in the fields of vehicle-to-vehicle, road-to-vehicle and vehicle-to-pedestrian communications that exchange information such as the relative positions and speed of vehicles and pedestrians, as well as of infrastructure radar systems using a millimeter wave band capable of detecting the presence of vehicles or pedestrians at and near intersections regardless of the weather or other environmental factors.

2.6. Promotion of ITS Using Radio Waves[12]

With respect to the use of wireless systems, the MIC is responsible for allocating the use of new frequencies and forming policies for technical standards, taking the usage situation of radio waves and interference with other wireless systems into account. In the field of ITS, MIC has already allocated frequencies and formulated technical standards for VICS, ETC, and ETC 2.0 systems to allow new systems to be introduced and existing ones to be made more sophisticated. It has also worked to promote the popularization of these systems.

2.6.1. Initiatives to Propagate and Enhance ITS Wireless Systems

In December 2011 the MIC revised ministerial ordinances and other documents related to the frequency band made available by the transition to digital terrestrial television broadcasting, formulating the 700 MHz Band Intelligent Transport Systems standard to lay the legal groundwork for the introduction of ITS wireless systems designed for safety support systems making use of that band.

Moreover, supplementing existing vehicle-to-vehicle and vehicle-to-infrastructure communications with the addition of infrastructure-to-infrastructure communication in these systems will expand the scope of information provided on approaching emergency vehicles or nearby traffic signals. Therefore, the ministerial ordinances and other documents necessary to the introduction of infrastructure-to-infrastructure communications were revised in July 2017 to facilitate the realization of more advanced driving support.

Following the approval of the primary allocation of the 77.5 to 78 GHz band required for 79 GHz high-resolution radars to radiolocation tasks at the November 2015 WRC-15 conference, Japan also prepared the legal framework necessary to expand the frequencies for these radars in January 2017 to enhance vehicle safety by further raising the accuracy of these radars, as well as to encourage the commercialization of automated driving. This new framework expands the range of frequencies available to these radars from the current 3 GHz band to the 4 GHz band, enabling the development of vehicle radars with even higher resolutions.

2.6.2. Assessments for the Realization of the Connected Car Society

As expectations surrounding connected cars are being raised by faster mobile networks, increased storage capacity, and advances in big data and AI, and with automakers and manufacturers of communication equipment worldwide are becoming increasingly active at establishing tie ups, the MIC established the Study Group Focusing on the Realization of Connected Car Society in December 2016 to work toward the realization of a safe and secure connected car society that creates new value and business.

More specifically, although the spread and development of connected cars is anticipated to bring about the opportunity to enjoy safe and convenient transportation services issues such as security threats arising from connecting to networks have also been raised. Consequently,

(a) new services and businesses for the upcoming connected car society,

(b) the structure of wireless communication networks that will support that society and,

(c) various other promotion measures

were assessed, and the vision of society arising from connected cars making use of wireless communication networks, as well as the relevant policies and roadmaps, were summarized in July 2017.

2. 6. 3. Trends in the International Standardization of ITS Wireless Systems

Deliberations are taking place in preparation for International Telecommunication Union (ITU) World Radiocommunication Conference 2019 (WRC-19) agenda items such as global or regional harmonized frequency bands for ITS. As usual, Japan will actively involve itself in international standardization by, for example, proposing new standards aimed at raising its superb ITS wireless system technologies to the level of international standards.

2. 7. Other

In preparation for welcoming between 40 and 60 million foreign travelers to Japan, and aiming to provide a pleasant stay as well as enhance the appeal of, and provide smooth transportation to, tourist sites, the Japan Tourism Agency, The Road Bureau of the Ministry of Land, Infrastructure Transport and Tourism, and other organizations set up a subsidy program in 2016 to stimulate emergency measures designed to establish a favorable environment for those travelers. Subsidies were granted for bus IC card systems, bus location systems, and other projects designed to enhance the convenience of transportation services, which represents part of the policy on those projects.

3 ITS Trends outside Japan (Fig. 1)[12]

3. 1. ITS World Congress 2017[13]

The 24th ITS World Congress, held in Montreal, Canada, from October 29 to November 2, 2017, was a resounding success, welcoming 8,000 visitors, approximately 300 exhibitors, and 65 participating countries.

The main topics discussed under the Congress theme of Integrated Mobility Driving Smart Cities were "Connectivity and Autonomy", "Infrastructure Challenges and Opportunities", and "The Smart Cities". The focus of the debates shifted from technology to applications to business, and vigorous discussions on social, organizational, commercial, administrative, and legislative problems were held.

3. 2. Asia-Pacific

Organizations involved in ITS in the Asia-Pacific region have formed ITS Asia-Pacific, which currently includes twelve member countries. In 2017, the 15th ITS Asia-Pacific Forum was held in Hong Kong, gathering participants from 19 countries and many regions.

3. 3. U.S.

Government-led projects based on the ITS Strategic Plan 2015-2019 issued by the U.S. Department of Transportation (USDOT) in November 2014, such as the Automation Program and the Connected Vehicle Pilot Deployment Program, are being carried out.

The latter is being undertaken in the three sites of New York, Wyoming and Tampa to evaluate connected vehicle effectiveness at reducing accidents and alleviating congestion, as well as to uncover operational issues in terms of security and privacy, and technical issues such as authentication.

The city of Columbus, Ohio is one of four cities receiving subsidies using the latest technologies to undertake the Smart City Challenge, which seeks to apply innovative urban transportation to solve social issues such as the concentration of the population in cities, transportation for elderly people, and poverty.

3. 4. Europe

The endorsement of the Declaration of Amsterdam on April 14, 2016 has triggered a policy of converging the previously independently advanced Horizon 2020, GEAR 2030, CAD, C-ITS Platform, and meeting of transport ministers into the Connected, Cooperative and Automated Mobility (CCAM) strategy.

In Horizon 2020, a large-scale L3 Pilot demonstration

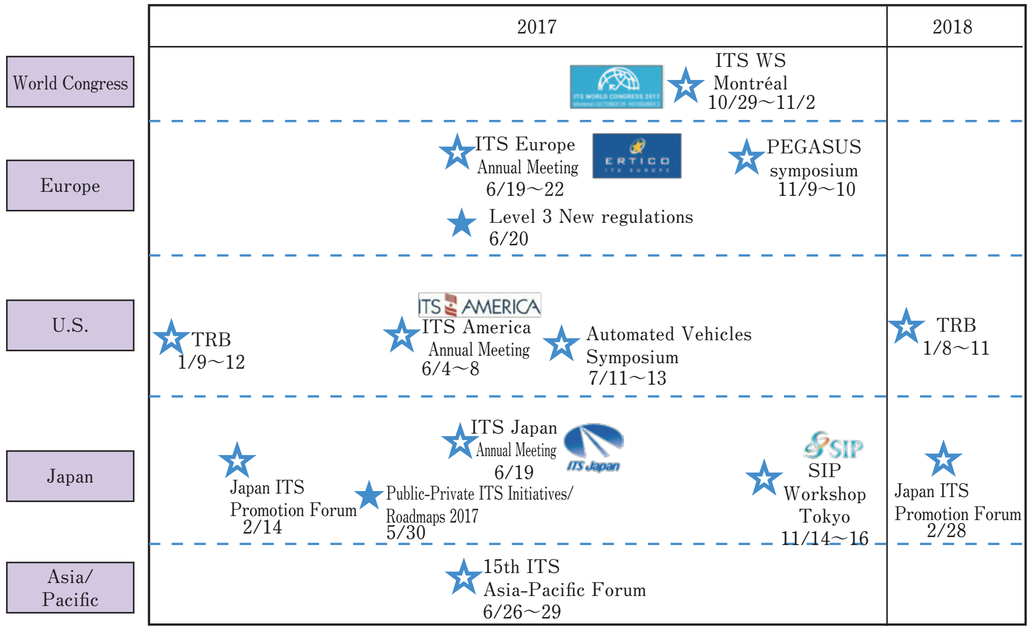

Fig. 1 World events related to ITS (mainly focused on international conferences).

with eleven participating countries has started, and involves pilot tests of level 3 automated driving and functional evaluations of level 4 automated driving. Similarly, the AUTOPILOT Project is evaluating automated driving services making use of IoT under the four operating modes of urban transportation, automatic parking, highway driving, and platoon driving.

3.5. International Activities

Led by the relevant ministries and agencies, Japan is actively promoting its various initiatives and engaging in exchanges by participating in events outside Japan and inviting specialists from other countries to Japan.

The government ministries and agencies involved in ITS, namely the Cabinet Secretariat, Cabinet Office, NPA, MIC, METI, and MLIT Road Transport Bureau held sessions and presented exhibitions at the 2017 ITS World Congress in Montreal and other ITS-related events in Western nations, and also engaged in meaningful exchanges with specialists from all over the world.

The various ministries and agencies are also actively engaged in standardizing their respective technologies and systems. Although there were various proposals and ongoing discussions in 2017, there is unfortunately not enough space in this article to list all the individual initiatives being carried out by government organizations.

References

(1) Website of IT Strategic Headquarters, http://www.kantei.go.jp/jp/singi/it2/ (in Japanese)

(2) 2017 Road Map of ITS Framework by Government and Private Sector, http://www.kantei.go.jp/jp/singi/it2/kettei/pdf/20170530/roadmap.pdf (in Japanese)

(3) Website of Vehicle Information and Communication System Center, http://www.vics.or.jp/en/index.html

(4) Website of Universal Traffic Management Systems Society of Japan, http://www.utms.or.jp/english/index.html

(5) ITS Technology Enhancement Association, https://www.its-tea.or.jp/english/

(6) Website of Advanced Safety Vehicle, Road Transport Bureau, Ministry of Land, Infrastructure, Transport and Tourism, http://www.mlit.go.jp/jidosha/anzen/01asv/ (in Japanese)

(7) Cabinet, Office, Government of Japan, Science Technology Innovation Strategy 2017, http://www8.cao.go.jp/cstp/sogosenryaku/2017.html (in Japanese)

(8) Website of Prime Minister of Japan and His Cabinet, Japan Reconstruction Strategy, http://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/saikou_jpn.pdf (in Japanese)

(9) Cabinet, Office, Government of Japan, Cross-ministerial Strategic Innovation Promotion Program, http://www8.cao.go.jp/cstp/gaiyo/sip/index.html

(in Japanese)
(10) Ministry of Economy, Trade and Industry, Website of Monozukuri/Information/Logistics and Service, http://www.meti.go.jp/committee/kenkyukai/mono_info_service.html/ (in Japanese)
(11) Ministry of Internal Affairs and Communications, Website of Information Communication Panel, http://www.soumu.go.jp/main_sosiki/joho_tsusin/policyreports/joho_tsusin (in Japanese)
(12) Website of International Transportation Systems Japan, http://www.its-jp.org/english/
(13) 24rd ITS World Congress, http://itsworldcongress2017.org/