INTELLIGENT TRANSPORT SYSTEMS

1 Introduction

Intelligent transportation systems (ITS) use communication between people, vehicles, and the roadside to exchange necessary information and address a variety of issues such as accidents, congestion, or environmental measures. These days, ITS is not limited to offering mobility systems that support the everyday life of people through the development and commercialization of road traffic-related technological breakthroughs and new mobility services such as the electrification of vehicles or information and communication technology (ICT), and artificial intelligence (AI) and other advanced technologies that underpin automated driving and mobility as a service (MaaS). The scope of ITS has expanded into opening new markets that involve building communities, revitalizing regions, activities targeted at decarbonization.

This article introduces ITS trends in and outside Japan based on information concerning the Japanese government ITS initiatives contributed by the Cabinet Office, National Police Agency, Digital Agency, Ministry of Internal Affairs and Communications (MIC), Ministry of Economy, Trade and Industry (METI), and Ministry of Land, Infrastructure Transport and Tourism (MLIT) for the 2022 edition of the annual report published by ITS Japan, as well as the results of surveys by that organization.

2 ITS Strategy and Future Course of the Japanese Government (Digital Agency)

2. 1. Public-Private ITS Initiatives/Roadmap 2020

In 2000, the Japanese government established the Basic Act on the Formation of an Advanced Information and Telecommunications Network Society (Basic IT Act) that establishes the basic IT vision for the nation. The objective of that law is to enable the government to swiftly and strategically advance policies concerning the creation of an advanced information and telecommunications network society. The act served as the basis for the formation of the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society (IT Strategic Headquarters). It is headed by the Prime Minister, and its membership consists of all national ministers as well as experts. The Public-Private ITS Initiatives/Roadmap was released under the auspices of that policy in 2014, and has been revised every year since then.

In today's Japan, changes in the structure of society exemplified by the declining birth rate and aging population, as well as the concentration of the population in urban areas, form a backdrop that brings to the fore both the social issues to resolve and the challenges of creating new economic value in the future in the field of road traffic. The regions, urban areas where private cars are the primary means of transportation, and urban areas with expansive public transportation systems each have their own characteristics, and the pending local issues, as well as the mobility needs of local residents and operators, vary from one community to the next. Keeping those factors in mind, and taking trends outside Japan into account, the Public-Private ITS Initiatives/Roadmap 2020 offers an example of a future vision of the mobility we should strive to achieve in 2030.

A concrete roadmap for automated transportation services in the first half of the 2020s was drawn up based on the systems that were established and the results of the field tests that were conducted until the 2019 fiscal year. The Public-Private ITS Initiatives & Roadmap 2020 was finalized in July 2020.

2. 2. Public-Private ITS Initiatives/Roadmap 2020: Initiatives to Date and Concept behind Future Initiatives

The automated driving systems that will be crucial to solving the social issues faced by Japan have been the

subject of development guided by clear objectives for the introduction to market of the three focus areas of building more sophisticated automated driving systems for private cars, establishing efficient logistics services that address the shortage of drivers, and offering autonomous driving services in rural areas and for the elderly. Pursuing these objectives will move us toward our goals of being the first country in the world to realize automated driving systems and of boosting our global industrial competitiveness. Public–private sector initiatives to achieve automated driving have led to the certification and commercialization of the world's first type approval for Level 3 automated vehicles and, in turn, to realizing driverless automated driving services.

At the same time, the core concepts of upcoming ITS roadmaps have been defined by drawing a future vision and setting the targets that will realize the mobility society of 2030 to establish an approach that identifies what must be now immediately based on the desired ideals and current issues. The Public-Private ITS Initiatives/Roadmap: Initiatives to Date and Concept behind Future Initiatives was approved by the IT Strategic Headquarters in June 2021.

2. 3. Future Initiatives

The public and private sectors have been collaborating on developing technology, setting up infrastructure, conducting field operational tests, and other initiatives aimed at further advancing ITS and realizing automated driving. The declining birth rate and aging of the population in Japan is setting high social expectations on more advanced ITS and the realization of automated driving as a means of securing mobility for the elderly or others with limited access to transportation, reducing the number of tragic traffic accidents resulting from mistakes made by elderly or impaired drivers, and solving issues such as the shortage of drivers in the regions or heavy congestion in the center of cities.

Moreover, digital technologies have been growing in importance as the spread of COVID-19 prompted people to stay home and avoid travel unless absolutely necessary, curtailed the holding of events involving large gatherings, spurred the adoption of telework to limit contact between people as much as possible, and otherwise altered society. These circumstances led to establishing the Digital Agency on September 1, 2021 to act as the control center for the digitalization of Japanese society.

In addition to automated driving, new mobility services capitalizing on digital technologies, such as the growth of MaaS or on-demand transportation and new delivery methods using drown or automated delivery robots are also becoming more common in the field of mobility.

Accordingly, the public and private sectors are working together toward a more efficient use of space offering significant added value that encompasses people and goods, as well as means of transportation ranging from walking to flying. They are doing so by both defining a future vision, and drawing up rules for sharing, linking, and using data, while taking day-to-day matters and energy issues into account. At the same time, they are evaluating an overall digital transportation society that will make the future vision a reality.

3 ITS Trends in Japan

3. 1. VICS

The Vehicle Information and Communication System (VICS) transmits the road traffic information compiled and processed at the Vehicle Information and Communication System Center using (a) FM multiplex broadcasting, (b) radio wave beacons, and (c) infrared beacons for display in three forms (text, simple graphics, and maps) on navigation systems and other onboard devices. Traffic information such as travel times, congestion conditions, and traffic restrictions are sent to navigation systems in real-time, offering not only greater convenience for drivers, but also contributing to smoothing traffic flow and improving fuel efficiency through appropriate route guidance. Nationwide spread of the system was completed in February 2003.

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 taxi probe data, pop-up advisories for all special weather, tsunami, or volcanic eruption warnings, and information on areas struck by heavy rains (50 mm/h or more).

Since 2019, work on integrating all probe data from civilian probes, infrared beacons, and ETC 2.0 to significantly reduce congestion, build a precise, autonomous driving-ready road traffic information network, and offer stable and accurate information in the event of a disaster has been conducted jointly with the Japan Road Traffic Information Center (JARTIC) in the context of realizing the world's most reliable road traffic information net-

work. Field operational tests on road traffic information services making use of probe data were initiated in Tokyo and six other prefectures in the Kanto region in April 2020, and expanded to the Sapporo area, as well as Aichi and Osaka prefectures in January 2022.

3. 2. UTMS (National Police Agency)

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.

(1) Main Applications of UTMS

(a) Advanced Mobile Information Systems (AMIS): These 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 March 2020, all prefectures in Japan had implemented AMIS.

(b) Fast Emergency Vehicle Preemption Systems (FAST): These systems use infrared 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 March 2020, 16 prefectures had implemented FAST.

(c) Public Transportation Priority Systems (PTPS): These systems control traffic signals to give priority to buses and other public transportation. They aim to reduce journey times and increase user convenience. As of the end of March 2020, 40 prefectures in Japan had implemented PTPS.

(d) Traffic Signal Prediction Systems (TSPS): These systems 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 March 2020, 46 prefectures in Japan had implemented TSPS.

(e) Pedestrian Information and Communication Systems (PICS): Aiming to support the safety of pedestrians, (particularly the elderly and people with visual impairment), these systems use approaches such as audio notification of traffic signal states and extending the duration of green lights to prevent accidents. As of the end of March 2020, 33 prefectures in Japan had implemented PICS.

(f) 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. As of the end of March 2020, 8 prefectures had implemented DSSS.

(7) Help system for Emergency Life saving and Public safety (HELP): These emergency response systems aim to reduce the time it takes for emergency vehicles to reach the scene of an accident and enable the prompt rescue of injured people, and rapid cleaning up of the site by transmitting information such as where the accident occurred via an on-board device or mobile phone in the event of an emergency. As of the end of March 2020, all prefectures in Japan had implemented HELP.

3. 3. Smartway (Road Bureau of MLIT)

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.

(1) Progress of ITS Propagation

(a) Extensive Provision of Road Traffic Data and Effectiveness: The number of vehicle navigation systems in Japan exceeded roughly 103.61 million units at the end of November 2022. Of these, approximately 73.97 million were compatible with real-time VICS road traffic information as of March 2022.

(b) ETC Popularization and Effectiveness: ETC has gained widespread acceptance since its full-scale introduction of in March 2001. As of the end of February 2022, 77.89 million on-board 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) Nationwide Spread of ETC 2.0 Services

(a) Start of ETC 2.0 Services: The Road Bureau of the 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 April 2021, roadside units had been set at approximately 1,800 locations along expressways throughout Japan).

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. Full-scale sales of ETC 2.0 on-board units began in August 2015, and new installations of such units had reached a cumulative total of approximately 7.47 million at the end of February 2022.

(b) 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, the following 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
- ETC 2.0 support services for vehicle operations management

3. 4. Advanced Safety Vehicles (ASVs, MLIT)

The seventh phase of the Advanced Safety Vehicle (ASV) Project aimed at promoting the development of automobiles equipped with advanced technology and at reducing traffic accidents was launched through government-industry-academia cooperation. Over the five years from 2021 to 2025, the project will (a) assess an effective strategy to promote the correct understanding and use of existing ASV technologies, (b) evaluate how safety technology that makes the system carry out safe operations even if the driver makes a mistake should intervene, (c) study shared specifications for the commercialization and broader adoption of cooperative safety technologies that makes use of communication and maps, and (d) examine and define the scope of responsibility borne by the system in automated driving. 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 driver emergency response systems).

3. 5. Automated Driving Systems

Many ministries and agencies are pursuing initiatives to commercialize automated driving systems.

(1) ITS Initiatives in the Strategic Innovation Promotion Program (Cabinet Office)

This comprehensive strategy, and the Japan Revitalization Strategy approved by the Cabinet in June 2013 led to establishing the Strategic Innovation Promotion Program (SIP) to enable the Council for Science, Technology and Innovation to fulfill its role as a control center and realize scientific and technological innovation. Benefiting from a budget that extends beyond ministerial and industry boundaries allocated directly by the Council for Science, Technology and Innovation, the SIP program fosters research and development that promotes everything from basic research to forward-looking end results (application and commercialization).

Research and development on systems for automated driving, one of the SIP challenges, was initiated in June 2014. The initiatives carried out over five years during the first phase of SIP–Automated Driving for Universal Services led to the formulation of unified cross-industry specifications for dynamic maps and other high-accuracy three-dimensional maps required for automated driving. Investments by electronics, maps, and measurement corporations, as well as automakers, led to the launch of Dynamic Map Platform Co., Ltd. This new company started preparing and commercially distributing high-accuracy three-dimensional maps for approximately 30,000 kilometers of expressway in March 2019.

For the second phase of SIP initiated in 2018, a new Automated Driving (Expansion of Systems and Services) project aimed at reaching the next level was launched in recognition of the need for automated driving development that will help resolve social issues such as reducing traffic accidents and congestion, securing transportation in depopulated regions, and alleviating driver shortages. The SIP-adus program goes beyond expanding the scope of automated driving from expressways to ordinary roads. It also promotes research and development, field operational tests, and other activities centered on cooperative areas best tackled through government-industry-academia collaboration for the purpose of promptly realizing a society in which all people enjoy a high quality of

life thanks to the commercialization of logistics and transportation services that make use of automated driving technology. There is a strong push for both coordination with the international community and government-industry-academia collaboration to combine the Tokyo Rinkai area field tests and the development of basic technologies, as well as to surmount the three obstacles presented by technology, legal systems, and the fostering of social acceptance.

Consult the SIP–Automated Driving for Universal Services Mid-Term Results Report (2018 to 2020) for details on the initiatives.

(2) Assessment the Legal System and Other Issues (National Police Agency)

Based on its responsibility to enforce the Road Traffic Act, which stipulates the rules of the road, the National Police Agency (NPA) has set up a study committee to address various issues, including those concerning the legislative system, in realizing automated driving. For the 2021 fiscal year, the Public-Private ITS Initiatives/Roadmap 2020 set the goal of launching remote monitoring-only driverless automated driving services in limited regions around 2022. That goal, along with the course set for investigative research in fiscal 2020, set the tone for a study of more concrete systems and traffic rules that would enable SAE level 4 automated driving, which does not assume the traditional presence of a driver focused on remote monitoring-only driverless automated driving in limited regions. A report on the results was compiled in December. An amended bill containing new stipulations to the Road Traffic Act for a system to permit special automated operation was submitted at the 208th session of the Japanese parliament, and passed in April 2022. Similarly, a framework for granting road use permission in the context of the Regulations Applicable to the Handling of Applications for Approval for Use of Road to the Field Operational Testing of Remotely Controllable Automated Driving Systems on Public Roads is being implemented based on the *Criteria for Granting Permission for Road Use in Demonstration Tests of Automated Driving on Public Roads*. Prefectural police departments are involved in discussions, and participating organizations are coordinating their efforts to support the safe conduct of public field operational tests.

(3) Advanced Mobility Service Research, Development and Social Implementation Project for L4 AD (*Road to the L4*) (METI)

Given the changing conditions surrounding the automotive industry exemplified by CASE and carbon neutrality, September 2021 saw the launch of *Road to the L4*, a new project to pursue initiatives starting with research and development and following through with field operational tests and social implementation. The initiatives aim to realize remote monitoring-only (level 4) driverless automated driving services in limited regions around 2022, expand those services to 40 locations around 2025, and achieve level 4 automated driving on expressways beginning in 2025. This project has assigned the overall investigation and study to a coordinating organization (the National Institute of Advanced Industrial Science and Technology), and relies on four themes to manage progress and other metrics.

The Road Traffic Act and other legislative amendments are paving the way for a transition to the social implementation phase of automated driving services. In that context, the fiscal 2021 Subcommittee on Business Discussions on Autonomous Driving Technologies convened in March 2022 and set a clear course for a full social implementation that will achieve automated driving services which will help solve social issues such as ensuring means of transportation as the population ages and declines, eliminate accidents and congestion and contributing to carbon neutrality. This will be pursued through the *Road to the L4* project initiatives centering on the four issues of technical development, setting up the infrastructure environment, raising social acceptance, and accelerating commercialization. At the same time, outcomes and results will be shared nationwide, and international trends will be taken into account.

(4) Roadside Support to Promote and Spread Automated Driving (MLIT)

The goal of encouraging the spread automated driving services that provide the elderly and others reliable day-to-day transportation and contribute to more efficient logistics will primarily be pursued through the use of disaster relief and safety subsidies to support systematic initiatives by local government aimed at establishing the necessary supporting infrastructure for automated driving, and at building towns and communities that make use of automated driving.

The higher volume of traffic than in semi-mountainous

regions and the confusing road layout in town centers also mean that spreading automated driving services will require building a safe and smooth driving environment that solves issues such as queues of following vehicles. Although achieving this calls for accurately apprehending surrounding traffic conditions, limits on the detection ability of on-board sensors at intersections or in curves with poor visibility and other challenges make it necessary to build a road infrastructure that facilitates the introduction of automated driving services through mechanisms such as capturing the position of oncoming vehicles or pedestrians via cameras or sensors, and sending that information to automated vehicles.

November 2021 marked the beginning of joint research collaboration between automakers, expressway companies, and on-board sensor manufacturers concerning guidelines for managing demarcation lines, techniques for transmitting predictive data, and other factors involved in realizing automated driving on expressways. These collaborative efforts remain ongoing.

(5) Assessment of New Communication Technologies for Automated Driving Systems (MIC)

With respect to the topics in the Automated Driving (Expansion of Systems and Services) project represented by Phase 2 (fiscal 2018 to 2022) of the Strategic Innovation Promotion Program (SIP) of the Council for Science, Technology and Innovation, the Ministry of Internal Affairs and Communications (MIC) is focusing on wireless communications systems as it collaborates with other government agencies involved in ITS to pursue research and development aimed at realizing automated driving.

Various assessments of promising wireless communication use cases identified in the outcomes of the automated driving system studies conducted until 2019 are underway. More specifically, the parties involved formulated a roadmap stipulating a course of action for V2X communication protocols after appraising the predicted adoption rate of automated vehicles as well as the conditions necessary for communication that were classified by frequency bands and protocols for new communication technologies in automated driving systems through 2020.

At the same time, some of the results of the research, development, and validation of technologies that produce a real time integrated picture of traffic conditions from the dynamic data available from various sources, and transmit the necessary relevant subset of details to automated vehicles conducted until 2020 to acquire a comprehensive view of surrounding traffic conditions were applied to the automated driving field tests carried out under SIP auspices.

3.6. Promotion of ITS That Uses Radio Beacons (MIC)

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 actual usage of radio waves and interference with other wireless communication into account. The ministry has allocated frequencies and formulated technical standards for intelligent transport systems (ITS) such as the Vehicle Information and Communication System (VICS), electronic toll collection (ETC) system, ETC 2.0, and 700 MHz band intelligent transport systems. In anticipation of the coming connected car society, in which new value and business will be created as almost all vehicles connect to a network, the Study Group Focusing on the Realization of Connected Car Society was established in December 2016. It has assessed a vision of a new society and policies to make it a reality, and is working to promote the further spread and technological advancement of ITS. An overview of priority measures and their achievements is presented below.

(1) Technical Studies on 5.9 GHz Band V2X Communication Systems

A major increase in communication traffic is anticipated as efforts to realize automated driving will introduce connectivity in almost all vehicles. Analyzing the separation distance required to avoid interference between wireless systems in terms of sharing the 5.8 GHz band already allocated as an ITS frequency in Japan with the ETC/ETC 2.0 systems that are already using it demonstrated that introducing new V2X systems relying on the same band to cope with the rise in communication traffic would be problematic. It is therefore urgent to secure a new frequency band for the introduction of such systems.

At the international level, the 5.9 GHz frequency band is under consideration for V2X systems. Studies on the technical requirements for newly introduced V2X systems to share that band with existing wireless systems began in 2020. In 2021, the tests to assess shared use with existing wireless systems (e.g., ETC, Wi-Fi, or FPU) that use the 5.9 GHz band or a neighboring band were

complemented with a survey of the actual conditions of existing wireless systems and an assessment of policies to introduce the new band based on those conditions.

(2) Initiatives to Spread 700 MHz Band Intelligent Transport Systems

In December 2011 the MIC revised ministerial ordinances concerning the 700 MHz band intelligent transport systems and laid the legal groundwork for the introduction of an ITS wireless communication system designed to support safety. In October 2015, the world's first vehicles equipped with that system were commercialized. Those vehicles make use of vehicle-to-vehicle and vehicle-to-infrastructure communication to offer driving safety support services such as crossing collision prevention, right- or left-turn collision prevention, rear-end collision prevention, and the provision of information on emergency vehicles.

Anticipating that the Japanese advanced road traffic systems could help reduce traffic accidents in other Asian countries with traffic conditions and frequency band allocations similar to those of Japan, the MIC started deploying the 700 MHz band driving safety support system to such countries in 2018. Among the field operational tests conducted in India in 2021, the city of Thiruvananthapuram conducted a test that involved emergency vehicles using V2X transmissions to road information signs or traffic signals to announce their approach, and then advising other vehicles to change lanes, or controlling the signals to facilitate the passage of emergency vehicles and reduce the time they need to reach a hospital, while the city of Ahmedabad tested a system that gives priority access to the bus rapid transit system (BRTS) primarily by controlling traffic signals in accordance with operational conditions. The results of these tests are being used as the basis to lobby for the adoption of national standards in India.

(3) Initiatives to Make Use of Fifth-Generation Mobile Communication Systems (5G)

More than just an ultra high speed development of the current mainstream 4G cellular phone technology, 5G is a next-generation mobile communication system with features such as multiple connections enabling many personal devices to connect to the network simultaneously, and ultra-low latency that enables the smooth operation of robots or other equipment even from remote locations. High expectations are being placed on 5G as the information and communication foundation of a full-fledged IoT era. The MIC has been solidifying its international cooperation efforts in terms of securing frequencies for 5G, carrying out research, development, and validation, and promoting standardization.

Due to its features, 5G is also expected to be used in automated driving. Between 2017 and 2019, in preparation for the opening of new markets resulting from 5G, the MIC conducted truck platoon driving field tests based on that wireless transmission technology in the context of test projects for 5G. Since 2020, based on individual regional or industry needs, local corporations, governments or other organizations took the lead in carrying out automated driving field tests in the context of test projects for local 5G, which enables users to flexibly configure spot systems in their buildings or within their premises.

3. 7. Promotion of International Standardization

(1) International Standardization Activities Concerning Smart Mobility Systems (METI)

The reduction of CO_2 emissions in the automotive sector is a necessary aspect of measures to address global warming, and a decrease in CO_2 is expected to result from the more efficient traffic flow achieved by the spread of autonomous driving. The need to reduce traffic accidents and provide assistance to vulnerable road users also means that autonomous driving systems are growing in importance year after year. ISO/TC 204 (Intelligent transport systems) has been working on international standards for autonomous driving systems. Japan has played a leading role in the related field of vehicle control technologies in its capacity as convener for WG 14 (Vehicle/Roadway Warning and Control Systems), which is in charge of international standardization activities in that field. However, standardization efforts aimed at the early adoption of various autonomous driving systems gaining more momentum in the U.S. and Europe year after year, along with the rapid rise of vigorous standardization activities in China, South Korea, and other Asian countries, are expected to further intensify the jockeying to take the lead in international standardization efforts. Consequently, based on the progress of regional standards in the U.S. and Europe and of the formulation of consortium standards and taking global interoperability into account, this project has focused on international standardization activities with respect to control systems related to automated driving and advanced driving support systems. These activities involve

preparing drafts of international standards, as well as reaching consensus at international conferences with other countries concerning both standardization items proposed by Japan at ISO/TC 204 via private sector experts and important standardization items proposed by other countries.

(2) International Standardization Activities Concerning Safety Technologies to Support Automated Driving Systems (METI)

Automated driving systems will help realize smooth road traffic, and offer the promise of solutions such as reducing traffic accidents, alleviating congestion, decreasing the burden on the environment for the various road traffic problems faced by society. Various forms of technological development and field tests targeting social implementations of automated driving systems are gaining in intensity year after year, both in and outside Japan. However, this also means that in automated driving, the recognition, decision-making, and operation tasks previously performed by humans will be entrusted to machines, making it vitally important to determine how to enhance safety performance and to convey that information to administrations, corporations, and the general public in an easy-to-understand manner (foster social acceptance). Standalone vehicles capable of driving autonomously will also make it vital to implement cybersecurity measures that preempt malicious uses for terrorist purposes. Among the ISO/TC 22 (Road Vehicles) standardization efforts concerning the safety technologies on which automated driving systems are built, this project has primarily supported international standardization activities for test methods and performance requirements in areas related to vehicle-side safety and reliability. The areas involved include cybersecurity, safety validation scenarios (e.g., for vehicle systems), software updates, safety of the intended functionality (SOTIF), and HMI. Those activities will support the formation of international rules compatible with the automated driving technology developed in Japan. The public and private sectors will continue to work hand-in-hand to allow Japan to collaborate with other countries involved and play a leading role in critical cases and fields.

(3) International Standardization Activities Concerning the Field of Information and Communication (MIC)

The MIC is actively submitting proposals on standardization and recommendations to the International Telecommunication Union (ITU), one of the specialized agencies within the United Nations. The ITS initiatives are conducted primarily as part of Working Party 5A, and proposals based on the frequency band use in Japan. Activities have centered on preparing recommendations for ITS wireless communication systems that use the 700 MHz and 5.8 GHz bands and harmonizing global and regional frequencies for ITS.

To contribute to further developing and spreading ITS wireless systems that use the 700 MHz band, the creation of a new Recommendation for vehicle-to-vehicle and vehicle-to-infrastructure communications has been proposed. Japan supported this activity by proposing a framework that compiles the standards in the U.S., Europe, and Japan for those forms of communication for the working documents used to formulate this new Recommendation. On the basis of that proposal, Japan filled in the contributing documents concerning its own vehicle-to-vehicle and vehicle-to-infrastructure communication standards. With assistance from Europe, South Korea and other regions, it also compiled that same information for various countries. Through cooperation with the U.S., Europe, and Asia-Pacific nations at related international conferences such as the APT Conference Preparatory Group (APG), ITU-R Recommendation M.2084 was released in September 2015. The technical requirements for the wireless interfaces for vehicle-to-vehicle and vehicle-to-infrastructure communications stipulated in that Recommendation reflect the European (ETSI), IEEE, and South Korean (TTA) standards, as well as the Japanese (ARIB) standards concerning 700 MHz band intelligent transport systems, and have been set as international standards.

To strengthen its international competitiveness, Japan actively engaged in international standardization activities at the 2019 World Radiocommunication Conference (WRC-19) that included joint public-private sector efforts to support the adoption of a recommendation on the desirability of globally harmonizing the disparate frequencies used for ITS in various countries, as outlined in Agenda Item 1.12, Global or regional harmonized frequency bands for evolving Intelligent Transport Systems. In addition, based on the proposal by Japan, SG5 Question 261, Radiocommunication requirements for connected automated vehicles (CAV), was assigned at the Plenary Meeting of the Radiocommunication Assembly (RA-19). Along with the above activities, the ITU-R, WP

5A, APG, APT Wireless Group (AWG) and other organizations are investigating standardization trends in various countries, building consensus with other parties, helping to prepare contributing documents and carrying out other liaison and coordination tasks that encompass assessments of the frequency bands necessary to evaluate shared frequency use with wireless LAN in the 5.9 GHz band and realize automated driving systems.

4 ITS Trends outside Japan

4. 1. Overview of the 27th ITS World Congress 2021 Hamburg

In 2021, the Congress was held in Hamburg, Germany, from Monday October 11 to Friday October 15 under the lingering shadow of the COVID-19 pandemic. It hosted 13,200 participants from 66 countries and regions. The growing rate of vaccination worldwide, along with the establishment of rules by both the City of Hamburg and the German government to prevent the spread of the disease made it possible to hold the event on site. Nevertheless, there was an inevitable drop in the number of participants from outside Europe. Under the theme of Experience Future Mobility Now, participants discussed automated driving and MaaS from the standpoint of carbon neutrality, a topic that attracts a notably high level in Europe in relation to the rest of the world. The event also feature various scenarios that emphasized the use of public and private sector data to achieve not only MaaS, but various other policies as well. In 2022, the Congress is scheduled to be held in Los Angeles, USA, where it was originally planned for 2020.

4. 2. Automated Driving Technology Trends

Efforts to implement automated driving in the various fields of private cars, low-speed shuttle bus for mobility services, trucks that connect logistics services depots, and robots providing last-mile delivery are being carried out worldwide. There is a general consensus that automated driving for mobility or logistics services following a fixed driving route or, in other words, automated driving (level 4) in limited areas will be achieved before automated driving for private cars used to travel everywhere.

Discussions at the ITS World Congress 2021 Hamburg focused on the actual deployment of automated driving and use of services. Differences in legal approaches to automated driving technologies between countries were explored, and the role legislation will play in the future was assessed. In contrast, cooperative ITS for the infrastructure is exhibiting steady, leading to discussions on its integration into existing businesses, matters that have to be evaluated for its commercialization, the use of smart traffic and other topics.

Field operational tests on the use of automated driving in public transportation demonstrate that there are still challenges to overcome. However, achieving automated driving under stricter restrictions than those on passenger vehicles looks promising, and there are ongoing efforts in that vein throughout the world.

4. 3. MaaS Trends

Due to the expectations placed on MaaS as a sustainable mobility solution, field tests are being carried out all over the world. However, realizing such services requires tackling many issues, such as public-private sector collaboration, data usage, and social acceptance. In particular, it is becoming clear that building a feasible business solely based on the income from transporting passengers is nearly impossible.

A variety of topics spanning the impact on consumer travel patterns, fairness and inclusion, standardization, business models, and the environment were also discussed at the ITS World Congress 2021 Hamburg. Many of those discussions highlighted various non-technical challenges as impediment to advances in this area. Examples include the complexity faced by many organizations in terms of getting stakeholders on board, a lack of trust and motivation regarding data sharing, and the resistance presented by regulations and existing business operators. Resolving those issues is viewed as the main challenge to the broad and long-term adoption of MaaS.