INTELLIGENT TRANSPORT SYSTEMS

1 Introduction

Intelligent Transport Systems (ITS) have dramatically contributed to road traffic safety, transportation efficiency, environmental protection, and convenience through the use of communication and electronic control technologies.

The scope of ITS as a scheme to support the lives of diverse people and help build vigorous communities has been expanding to cover mobility as a service (MaaS), smart cities, as well as automated driving, which advanced technologies such as information and communication technology (ICT) and artificial intelligence (AI) have been bringing closer to reality. This article introduces the Japanese government's ITS strategy, along with ITS trends in and outside Japan based on information concerning the Japanese government ITS initiatives contributed by the Cabinet Secretariat, Cabinet Office, National Police 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 2021 edition of the annual report published by ITS Japan, as well as the results of surveys by that organization.

2 ITS Strategy of the Japanese Government

2. 1. Public-Private ITS Initiative/Roadmaps 2019

In 2000, Japan established the Basic Act on the Formation of an Advanced Information and Telecommunications Network Society (Basic IT Act) that defines the basic IT vision for the country. It has since continued to issue IT policies congruent with the digital age.

After the government agencies in charge of the various systems completed their evaluations of specific system implementations based on the Charter for Improvement of Legal System and Environment for Automated Driving Systems, the MLIT drew up the Guideline Regarding Safety Technology for Automated/Autonomous Vehicles in September 2018. The Guideline clearly stipulates the safety requirements that automated vehicles must meet. The May 2019 revision of the Road Transport Vehicle extended the scope of the safety regulations to cover autonomously operated devices to ensure safety integrally throughout all processes for autonomous vehicles or other devices, from their design and manufacturing to their use. At the same time, the assignment of conditions on the use of autonomously operated devices was vested in the Minister of Land, Infrastructure, Transport and Tourism. The safety regulations concerning such automated driving systems, along with the amended Road Transport Vehicle Act, came into effect in April 2020. At the same time, the Road Traffic Act was revised in May 2019 to include stipulations on driver obligations with respect to the commercialization of automated driving technologies. It came into effect in April 2020.

In the wake of such amendments to regulatory systems, the Public-Private ITS Initiative/Roadmaps 2019 presented a clear vision of what autonomous driving should look like to fully achieve the goals set for the imminent realization of autonomous driving on highways and unmanned autonomous driving mobility services in designated areas. The roadmap also summarizes remaining issues and initiatives such as sustainable business models. In light of the various initiatives launched over the past few years, MaaS in the age of automated driving was also assessed from the perspective of road traffic. The Public-Private ITS Initiative/Roadmaps 2019 was finalized in June 2019.

2. 2. Public-Private ITS Initiative/Roadmaps 2020

In 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 ar-

eas, 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 Initiative/Roadmaps 2020 offers an example of a future vision of the mobility which 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 Initiative/Roadmaps 2020 was finalized in July 2020.

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 network. 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 are still underway.

3. 2. UTMS

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 2019, 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 2019, 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 2019, 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 2019, 42 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 2019, 32 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 2019, 8 prefectures had implemented DSSS.

3. 3. Smartways

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 98.72 million units at the end of November 2020. Of these, approximately 70.48 million were compatible with real-time VICS road traffic information as of March 2021.

(b) Electronic Toll Collection System (ETC) Popularization and Effectiveness: ETC has gained widespread acceptance since its full-scale introduction of in March 2001. As of the end of December 2021, 74.06 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 2018, roadside units had been set at approximately 1,700 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 6.1 million at the end of February 2021.

(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 initiatives below are being promoted to optimize transport by truck via the application of data on routes traveled and usage times collected with ETC 2.0.

- 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)

Since 1991, the Road Bureau of MLIT has promoted the development, commercialization and popularization of ASVs through coordination between government, industry, and academia. The sixth phase of the Advanced Safety Vehicle (ASV) Project compiled the results of studies on the advanced safety technologies necessary to achieve automated driving, which covered technical and other requirements for driver emergency response systems expanded to pull over on the road shoulder, intelligent speed adaptation (ISA) systems, and driver monitoring, as well as of activities to commercialize ASV technologies. 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).

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 compre-

hensive 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.

(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. The Public-Private ITS Initiative/Roadmaps 2020 sets the goal of launching remote monitoring-only driverless automated driving services in limited regions around 2022. With that goal in mind, the rules for SAE level 4 automated driving, which do not assume the traditional driver is present, as well as measures to ensure safety if circumstances that cannot be handled by the system arise, were studied in 2020.

In September 2020, the *Criteria for Granting Permission for Road Use in Demonstration Tests of Automated Driving on Public Roads* were revised. These regulations serve as a reference for handling requests to obtain approval to use public roads in field operational tests for remotely controlled automated driving systems involving a driver using telecommunication technology to monitor and operate the vehicle from a remote location, as well as for vehicles that are operated using devices that differ from the usual steering wheel and brakes during manual driving ("specially-equipped motor vehicles"). The revision includes amendments to the stipulations concerning a monitoring and operation by a driver when using a test vehicle equipped with an automated driving system, as well as a streamlining of the process for applying for approval to use public roads in demonstration tests of specially-equipped motor vehicles.

(3) *Progress Report on Efforts to Support the Development of Autonomous Driving Technologies and Create Adequate Policies* by the Subcommittee on Business Discussions on Autonomous Driving Technologies (METI): The Subcommittee on Business Discussions on Autonomous Driving Technologies was established in February 2015 under the auspices of the Director-General of the Manufacturing Industries Bureau of METI and of the Director-General of the Road Transport Bureau of MLIT to support an all-Japan government-industry-academia framework to commercialize autonomous driving. It consists of automakers, suppliers, and other experts who, over the last six years, have analyzed the challenges of turning automated driving into a business in accordance

with advances in the development of technology and establishment of legislative or administrative systems related to automated driving. Based on that analysis, the subcommittee has drawn up a future vision, identified challenges and fostered initiatives in cooperative areas, promoted field test projects, and otherwise encouraged the necessary efforts.

In 2020, the Next Projects WG was established under the Subcommittee on Business Discussions on Autonomous Driving Technologies. The WG planned a schedule for the next projects to work on from 2021 to around 2025 based on the course of action outlined in the *Roadmap for Deployment of Autonomous Driving Services* formulated in fiscal 2019. A Service Vehicles Cooperation WG was also established under that same subcommittee. That WG prepared a course of action concerning the matters to keep in mind to enable entities conducting field tests to do so safely and smoothly, and pave the way for commercialization. Among the ten areas it has specified, the subcommittee has identified potential issues to address in terms of future cooperative areas as it continues to promote ongoing cooperative area initiatives. These results were consolidated and released in Version 5.0 of the *Progress Report on Efforts to Support the Development of Autonomous Driving Technologies and Create Adequate Policies* in April 2021.

(4) Autonomous Driving Services in Semi-Mountainous Regions Using *Michi no Eki* Roadside Stations as Hubs and Support from Road Administration Authorities (Road Bureau, 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 is primarily 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 building towns and communities that make use of automated driving.

In semi-mountainous regions, the aging of the population and termination of public transportation services is making securing transportation for people and goods a pressing issue. Consequently, field tests to establish autonomous driving services based on the hubs represented by *michi no eki* roadside stations, where goods for sale, clinics, and administrative and other everyday life services tend to concentrate, have been carried out at 18 locations throughout Japan since 2017.

The 2017 field tests consisted of short-term (about 1 week each) evaluations primarily intended for technical validation. The 2018 field tests were longer term evaluations (one to two months each) that focused on issues such as validating measures to secure driving space for autonomous vehicles and building business models to offer sustainable services. In November 2019, a social implementation based on the field test results was initiated at the Kamikoani *michi no eki* in Akita Prefecture. Regions that complete their preparations will continue to gradually apply their social implementation.

(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 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 autonomous driving system studies conducted until 2019 are underway. More specifically, the conditions necessary for communication have been classified in technical terms by frequency band and protocol, and their validity has been verified.

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 transmits the necessary relevant subset of details to automated vehicles is being conducted to acquire a comprehensive view of surrounding traffic conditions.

3.6. Promotion of ITS That Uses Radio Beacons

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), elec-

tronic 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 and has assessed a vision of a new society and policies to make it a reality. That assessment is serving as a basis to make ITS more widespread and increase its sophistication.

(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. The technical studies in that initial year involved working with current licensed wireless stations and conducting small-scale tests to assess shared used with existing wireless systems (e.g., ETC, Wi-Fi, or FPU) that use the 5.9 GHz or a neighboring band.

(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.

The inclusion of the target of reducing fatalities from traffic accidents by 50% by 2020 in the sustainable development goals (SDGs) defined by the United Nations reflects the growing international interest in measures against traffic accidents. 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.

In 2020, field tests were conducted in Taiwan and India. In Taiwan, various field tests integrating the results of similar test conducted in the Philippines in 2019 were carried out. These included a test involving vehicles entering an intersection using V2X communication to notify roadside units of their approach, and alerting other vehicles driving on the roads at that intersection via road signs or on-board units. In another test, V2X communication and road information signs were used to alert other vehicles based on the location of motorcycles obtained by reading their RFID tags through on-board sensors. A third test relied on millimeter wave radar set on the roadside to detect the position of vehicles. In India, a test conducted in the city of Ahmedabad that involves emergency vehicles using V2X communication to notify road information signs or traffic signals of 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 was expanded in scale.

(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 is currently working to secure, carry out research and development on, and validate the frequencies allocated to 5G, while also intensifying international coordination and other efforts to advancement international standardization activities. In March 2020, 5G commercial services were launched in some cities.

Due to its features, 5G is also expected to be used in automated driving. Between 2017 and 2019, in prepara-

tion 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. In 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 Automated Driving & Advanced Driving Support Systems (METI): Automated driving systems will help realize safe and 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 human-machine interfaces (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 har-

monizing 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 ITS World Congress

The 2020 ITS World Congress was scheduled to take place in Los Angeles, U.S., over five days from October 4 to 8, but had to be cancelled because of the COVID-19 pandemic. However, the Congress is scheduled to be held in Hamburg, Germany, from October 11 to 15, 2021, under the theme of “Experience Future Mobility Now”.

4. 2. Automated Driving Technology Trends

Expectations placed on automated driving by society remain high, and while it is likely to be achieved in the long term, there are still many challenges to overcome. In the short term, global experts on automated driving have identified (a) the impossibility of achieving autonomous driving by developing only on-board technologies, (b) the development of the infrastructure, including the driving environment, (c) the establishment of legal systems and frameworks, and (d) the cooperation of stakeholders, including communities and nearby residents, as essential requirements to achieve automated driving.

Meeting these requirements requires cities combined with urban planning, and community level field tests. Future visions are being drawn up, and social implementations prepared in living laboratories such as the automated driving pilot implementation in three Singapore new towns (Punggol, Tengah, Jurong Innovation District), the future city presented in the Blueprint for Autonomous Urbanism by the National Association of City Transportation Officials (NACTO), and Woven City by Toyota.

In 2020, the need to limit contact between people due to the impact of COVID-19 led to intensified initiatives with respect to (a) the increased need for private or other forms of personal vehicles, (b) the assessment of infection prevention measures in automated vehicles for transportation services (e.g., buses or shuttles), and (c) the last mile (including the final 50 feet) in logistics services.

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 busi-

ness solely based on the income from transporting passengers is nearly impossible.

Proposed MaaS business models include the monthly subscription fee model, the premium model based on door-to-door service, and models relying on fees for the use of a platform or application, all of which require a large user base to secure income. In Belgium, this situation has led to the emergence of corporations that are replacing the widespread company car system with MaaS. This illustrates how MaaS is expanding to B2B rather than remaining limited to B2C.

In addition to producing new value by linking traffic data with other types of data, it will be important for to implement actual services through cooperation between local governments and corporation, or public policy, to make MaaS widespread and well-established.