INTELLIGENT TRANSPORT SYSTEMS

1 Introduction

Intelligent Transport Systems (ITS) achieve dramatic improvements in road traffic safety, transportation efficiency, and comfort by connecting people, roads, and vehicles using communication technologies. They have also been contributing to the realization of a vigorous society that is convenient for its citizens in various ways, including conserving energy through the alleviation of traffic congestion and the protection of the environment.

More recently, ITS have been moving beyond the stage of applying advanced technologies to the transportation sector and expanding to cover initiatives aimed and resolving growing and increasingly serious social issues.

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 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.

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 on addressing the international spread of the Society of Automotive Engineers (SAE) definitions of automated driving levels since the autumn of 2016 and 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 2017 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. The team formulated the Charter for Improvement of Legal System and Environment for Automated Driving Systems, which stipulates (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, initiating the discussions necessary to make prompt amendments in line with international agreements and, (c) in the unlikely event of an accident, taking advantage of the existing Automobile Accident Compensation Act, and enabling the prompt rescue of victims. The Charter for Improvement of Legal System and Environment for Automated Driving Systems that indicates courses of action, such as assessing the mandatory installation of drive recorders, aimed at clearly defining responsibilities, was compiled in April 2018.

The contents of that charter, the categorization of field tests by purpose, and summaries of initiatives to improve social receptivity for each stakeholder involved in autonomous vehicles, were collated in the Public-Private ITS Initiatives/Roadmap 2018, which was approved by the IT Strategic Headquarters on June 15, 2018.

After the formulation of the Charter for Improvement of Legal System and Environment for Automated Driving Systems, the government agencies in charge of the various systems evaluated specific legislative measures, and in September 2018, the Ministry of Land, Infrastructure Transport and Tourism (MLIT) drew up the Guideline Regarding Safety Technology for Automated/Autonomous Vehicles, which clearly stipulates the safety requirements that must be met by autonomous vehicles.

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

March 2019 are as follows.

2.2.1.1. 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 March 2019, all prefectures in Japan had adopted AMIS.

2.2.1.2. 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 adopted FAST.

2.2.1.3. 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 March 2019, 40 prefectures had adopted PTPS.

2.2.1.4. 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 March 2019, 42 prefectures had adopted TSPS.

2.2.1.5. 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 March 2019, 32 prefectures had adopted PICS.

2.2.1.6. 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 adopted DSSS.

2.2.2. SIP Research and Development

2.2.2.1. Initiatives to Reduce the Costs of ITS Wireless Roadside Units

The possibility of reducing costs by integrating the ITS wireless roadside units that use the 700 MHz band for radio communication into the traffic signal control unit was evaluated.

2.2.2.2. Initiatives to Enhance Pedestrian Information and Communication Systems (PICS)

Enhanced PICS that make use of smartphones are being developed, and the basic design for demonstration tests was established in 2015, with the building and validation of the effectiveness of the model system both carried out from 2016 to 2018. Preparations by prefectural police departments based on those results are scheduled to being in 2019.

2.2.2.3. Initiatives to Enhance Driving Safety Support Systems (DSSS)

An investigation into further enhancing these systems was conducted in 2016. Based on results demonstrating the usefulness of support to prevent failures to notice pedestrians ahead when making a left turn, a model system that implements the provision of information for left turns in addition to the existing provision of information for right turns was built in Ibaraki Prefecture in 2017. Validation of effectiveness using the model system was carried out in 2018.

2.3. 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. 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 making use of route data, as well as a well-rounded lineup of private services, are being promoted.

2. 3. 1. Progress of ITS Propagation

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

The number of vehicle navigation systems in Japan exceeded roughly 88.68 million units at the end of December 2018. Of these, approximately 62.20 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. 1. 2. ETC Popularization and Effectiveness[5]

ETC has gained widespread acceptance since its full-scale introduction of in March 2001. As of the end of December 2018, over 64.59 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. 3. 2. Nationwide Spread of ETC 2.0 Services

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

The Road Bureau of 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 April 2018, 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. 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 3.41 million at the end of December 2018.

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

Expositions such as the September 2018 ITS World Congress in Melbourne and the CEATEC Japan 2018 trade show featured events and 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. 2. 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 vehicle 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.

Field testing of support services for vehicle operations management using ETC 2.0 was carried out and evaluated starting in November 2016, and the services were fully introduced and made broadly available in August 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 2018. To enable safe driving without misunderstandings with respect to currently commercially available vehicles equipped with technology that partially automates driving operations, the expression driving support vehicles has been defined as the proper term to use when describing level 1 and 2 vehicles.

In addition, the ASV Project continues to play a supporting role for the commercialized advanced safety technologies it promotes (such as collision mitigation braking systems, lane departure warning systems, and vehicle stability control systems) as well as for special tax measures that apply to trucks and buses with collision mitigation braking and vehicle stability control systems.

2. 5. Automated Driving Systems

Based on the mid- to long-term direction stipulated in the basic plan for science and technology, the June 2013 Comprehensive Strategy on Science, Technology and Innovation[7] and the Japan Revitalization Strategy[8] Cabinet decisions 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) of the research and development of SIP phase 1 automated driving systems which, since June 2014, have been the object of efforts directed at reducing traffic accidents and realizing a next-generation urban transportation system through the early commercialization and propagation of automated driving systems. 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 call for joint government-industry-academia efforts. In fiscal 2017 and 2018, the period designated for the completion of the first phase of SIP, large-scale demonstration tests focused on five crucial matters 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.

For dynamic maps, studying the formulation and standardization of high-definition 3D maps for automated driving as well as technologies for automatic mapping and incremental updates aimed at commercialization, led to commercial distribution over approximately 30,000 kilometers on expressways. For HMI, data was collected and accumulated on test courses and public roads with the cooperation of the participating companies to validate factors such as driver understanding of the system, ascertaining readiness state, interaction with pedestrians and non-autonomous vehicles. Guidelines for achieving level 3 autonomous driving were formulated, and international standards were proposed. For information security, evaluations using the point of view of the attacker (hacker) were developed to establish vehicle- and component-level evaluation procedures and international standardization, and delegated the Japan Automotive Software Platform and Architecture (JASPAR)[10] in the form of industry guidelines. For the reduction of pedestrian accidents, development focused on vehicle-to-pedestrian communication terminals aimed at reducing accidents involving pedestrians or bicycles, which account for half of all fatal traffic accidents, as well as on technology to measure the location of pedestrians with a high degree of precision and to estimate their behavior. The effectiveness of the resulting technology was then validated on public roads. For next-generation urban traffic, advanced rapid transit (ART) technology focusing on precise arrival control technology was developed, and field tests on public roads were conducted in preparation for the realization of ART information centers linked to dynamic maps.

Consequently, issues in the five critical technological areas have been steadily resolved through large-scale field tests, and efforts have borne fruit. In 2018, the final year of the first phase of SIP, the 5th SIP-adus Workshop international conference involving globally recognized leading experts on the research themes, was held in November. The conference provided an opportunity to convey information on the SIP phase 1 automated driving systems initiatives to people both in and outside Japan.

The second phase of SIP will establish a new Automated Driving (Expansion of Systems and Services) project aimed at reaching the next level. In addition to expanding the scope of automated driving from expressways to ordinary roads, there is a strong desire to commercialize logistics and transportation services that make use of automated driving technology as early as possible. Accordingly, using the Tokyo Olympic and Paralympic Games as a milestone, SIP phase 2 seeks to combine the Tokyo Rinkai area field tests and the development of basic technologies and, in coordination with the international community, surmount the three obstacles of technology, legal systems, and social acceptance through government-industry-academia collaboration to pave the way for commercialization.

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). In 2018, initiatives based on the revised schedule in the Action Plan for Realizing Automated Driving, Version 2.0 were carried out and their progress was managed. In addition, the form safety evaluations should take and the training and securing of human resources was studied, and a report is currently being prepared. An outline of the Action Plan for Realizing Automated Driving, Version 2.0 is presented 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.

With respect to the international standardization of automated driving and advanced driver assistance systems and the building of a foundation for their propagation, ISO/TC 204 (Intelligent transport systems) has been working on international standards for the fundamental basic technologies in automated driving systems. Japan has played a leading role in the related field of vehicle control technologies by, for example, obtaining the position of convener for WG 3 (ITS Database Technologies) and WG14 (Vehicle/Roadway Warning and Control Systems), which are in charge of international standardization activities in those fields. However, with standardization efforts aimed at the early adoption of automated driving systems gaining more momentum in the U.S. and Europe year after year, and rapid rise of vigorous standardization activities in China, South Korea, and other Asian countries, jockeying to take the lead in international standardization efforts is expected to intensify further.

Consequently, in terms of advanced driving support systems and related systems such as dynamic maps and vehicle control systems, and in light of the progress of regional standards in the U.S. and Europe and of the formulation of consortium standards, METI has participated in international conferences to reach consensus with the international community, as well as supported the preparation of a draft of international standards for performance requirements and other international standardization activities related to standardization items proposed by Japan in ISO/TC204 while keeping global interoperability in mind, METI.

Working with automakers the National Police Agency examined methods of providing the traffic signal information required to achieve automated driving in the context of the Strategic Innovation Promotion Program (SIP) Automated Driving (Expansion of Systems and Services) project goal of using ITS wireless roadside units to achieve advanced provision of signal information. To lay the groundwork for the Tokyo Rinkai field test scheduled for October 2019, preparations to install ITS wireless roadside units capable of transmitting that signal information are underway. In addition, the agency is conducting a technical review of the various issues and of case studies in and outside Japan as part of research related to cloud-based methods of providing signal information that takes the requests of private sector operators into consideration.

The MLIT is working on field tests aimed at achieving the government goal of establishing automated driving transportation services in specific regions by 2020. Automated driving is expected to be highly effective at resolving issues such as reducing traffic accidents and securing transportation for the elderly. In semi-mountainous regions, were the population is aging, public transportation is being discontinued, and securing transportation for day-to-day life and logistics has become a pressing issue, field tests to establish automated driving services that use michi no eki roadside stations, where goods for sales, clinics, and administrative and other everyday life services tend to concentrate, as hubs have been carried out since 2017.

The 2017 field tests, which consisted of short-term (about 1 week each) evaluations primarily intended for technical validation, were conducted at 13 locations nationwide. The 2018 field tests were longer term evaluations (one to two months each) that focused on issues such as validating measures to secure the running space of autonomous vehicles and building business models to offer sustainable services.

In 2019, the next step will be to expand the content of the tests and continue to pursue initiatives leading to the social implementation of automated driving using michi no eki roadside stations as hubs by 2020.

In the context of issues covered the SIP phase 1 automated driving systems and phase 2 automated driving projects, the Ministry of Internal Affairs and Communications (MIC) is collaborating with other government agencies involved in ITS to pursue, from the standpoint of wireless communication systems, research and development aimed at realizing automated driving.

Specifically, SIP phase 1 measures included conducting technological development and field tests in the areas 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. In 2018, field tests were carried out on public roads, and research and development concerning technologies to improve automated driving safety through wireless communication systems was unified. Similarly, SIP phase 2 measures in 2018 included investigating new communication technologies for automated driving systems. With respect to the use of existing or new wireless communication systems in automated driving systems, (a) the automated driving scenarios and wireless systems therein envisioned in the field tests carried out in Japan and other countries, as well as the wireless communication systems being discussed by international standardization groups, were investigated, (b) the results of that investigation was used to list the wireless communication systems used, or considered for use, in automated driving, (c) the automated driving scenarios in which wireless communication systems are used, or expected to be used, were summarized, and (d) the correlation between the scenarios and the wireless communication systems that merit continued attention was defined.

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 Spread and Enhance 700 MHz Band Intelligent Transport Systems

In 2011, the MIC formulated 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 in that band. This was followed by the compilation of security requirements for driving safety support systems in the 700 MHz band (June 2014) and of security guidelines for the building of driving safety support systems in the 700 MHz band (July 2015).

In October 2015, the outcome of those initiatives led to the world-leading commercial release of vehicles equipped with V2X communication systems. The vehicles receive information via vehicle-to-vehicle or vehicle-to-infrastructure communication, enabling the use of driving safety support services such as crossing collision prevention, right-turn collision prevention, rear-end collision prevention, and the provision of information on emergency vehicles. In light of the recent international interest in measures against traffic accidents, the MIC considered that Japanese driving safety support communication systems in the 700 MHz band could help reduce accidents in other Asian regions where accidents are frequent, buildings are densely packed, roads are narrow, and traffic conditions are otherwise similar to those in Japan. Starting in 2018, driving safety support communication systems in the 700 MHz band have been deployed outside Japan, and feasibility studies including vehicle-to-vehicle and roadside-to-vehicle communications were carried out in Thailand, the Philippines, Taiwan, and India.

2. 6. 2. Initiatives for the Realization of the Connected Car Society

As expectations surrounding connected cars are being raised by faster mobile networks with increased storage capacity resulting from increasingly established fifth-generation mobile communication technology (5G), and advances in IoT 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. The study group submitted a report in August 2017.

With the volume of data exchanged by vehicles anticipated to grow with the advent of various services for connected cars, it has become necessary to create advanced wireless communication systems that ensure reliability, robustness, and real time performance of vehicle communications in the connected car society. Therefore, the MIC initiated studies of new wireless systems for connected cars to look at (a) wireless communication systems that enhance the existing dedicated short-range communication (DSRC) systems used in the 700 MHz and 5.8 GHz bands, (b) new ITS wireless systems that use cellular technology to complement the DSRC systems, and (c) assessing technical requirements and other conditions concerning wireless communication systems in the 60 GHz band, which is raising expectations in areas such as the transfer of large amounts of data, as promising new wireless communications for use in the connected car society. The ITS wireless communication systems covered by those studies are being assessed in terms of (a) envisioned use cases and the technical specifications to satisfy them, (b) analysis of interference with existing wireless communication systems and technologies to avoid that interference, (c) communication-related security, (d) data platforms to allow appropriate mutual use between wireless communication systems, and (e) technical requirements involved in the combined use of several wireless communication systems, in the context of technical test administration resulting from fees for the use of radio waves.

2. 6. 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 characterized by multiple connections allowing 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 its early realization to serve as an ICT foundation for a fully established IoT era. In preparation for the realization of 5G in 2020, the MIC is currently working to secure, carry out research and development on, and collectively validate the frequencies allocated to 5G as well as intensifying international coordination efforts and taking other actions related to the advancement of international standardization activities. Upon allocating 5G frequencies to cellular phone operators in April 2019, the government made measures such as making the service to available in all prefectures within two years and establishing 5G advanced specified base stations (new stations) in 50% or more of the meshes (10 square kilometers) mandatory to promote the broad and steady deployment of 5G throughout Japan.

Given the expectations placed on 5G in automated driving technologies, and in the context of comprehensive field tests carried out to create new markets via the realization of 5G, the MIC validated truck platoon driving as well as remote vehicle monitoring and operation, by conducting field tests on test courses and, in some cases, on expressways in 2018.

2. 6. 4. Promotion of International Standardization

The MIC is actively making proposals to, and otherwise engaging with, the ITU on matters concerning standards and recommendations as part of its international standardization activities in the field of information and communication. Japan's ITS activities, conducted primarily as part of ITU-R, include actions such as the proactive presentation of proposals based on its current frequency band use to Working Party 5A (WP 5A, responsible for land mobile service) and Working Party 5B (WP 5B, responsible for the radiodetermination service) of the ITU-R Study Group 5 (SG 5). Activities have centered on preparing recommendations for ITS wireless communication systems that use the 700 MHz and 5.8 GHz bands, revising the Recommendations for, and allocating frequencies to, 79 GHz band high resolution radars, and harmonizing global and regional frequencies for ITS.

In addition, following the approval Global or regional harmonized frequency bands for evolving Intelligent Transport Systems, proposed via APT, as part of Agenda Item 1.12 by WRC-19, ITU-R, WP 5A, APG, AWG and other groups are investigating standardization trends in various countries, building consensus, 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 GHz band and to realize automated driving systems to achieve global and regional harmony between the frequency bands used for ITS in various countries.

3 ITS Trends outside Japan[13]

3. 1. ITS World Congress 2018[14]

The 25th ITS World Congress, held in Copenhagen, Denmark, from September 17 to 21, 2018, was a resounding success, welcoming over 10,000 visitors, approximately 400 exhibitors, and 96 participating countries.

The main topics discussed under the Congress theme of ITS-Quality of Life were as follows.

(a) Connected and automated transport

(b) Mobility services from transport to mobility

(c) Transport networks evolution

The changeover from means of transportation to a mobility services perspective, the progress of MaaS introduction and its attendant issues, the systematic issues involved in commercializing automated driving, information networks, measures against global warming, and automotive electrification were the main points at the center of lively debates.

3. 2. Asia/Pacific[15]

Organizations involved in ITS in the Asia-Pacific region have formed ITS Asia-Pacific, which currently includes twelve member countries. In 2018, the 15th ITS Asia-Pacific Forum was held in Fukuoka, Japan, from May 8 to 10. Held in Japan for the first time since the 1st event in Tokyo 22 years ago, the forum attracted many people from inside and outside Japan, welcoming 3,556 participants, 80 exhibitors, and 27 participating countries.

3. 3. The U.S.

The U.S. Department of Transportation (USDOT) released the Federal Automated Vehicles Policy in September 2016, Automated Driving Systems: A Vision for Safety 2.0 in 2017, and Preparing for the Future of Transportation: Automated Vehicles 3.0 in October 2018. These guidelines on automated driving maintain the self-certification guideline for safety criteria and evaluation methods (vehicle safety regulations), require automakers to take the initiative in ensuring safety and to disclose information in accordance with the guideline. They also propose a policy model for driving methods (road traffic legislation) that eschews direct intervention in state government jurisdictions and recommends that states take the lead in establishing policies that remain consistent across their borders.

One ITS initiative, the Connected Vehicle Pilot Deployment Program, was initiated in 2014 and has been evaluating connected car technologies in the three regions of New York, Wyoming and Tampa, carrying out benefit evaluations for major milestones such as reducing accidents, alleviating congestion, and environmental measures.

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. A second ministerial-level meeting was subsequently held to build a unified systematic framework for the commercialization of cooperative and automated driving by 2019.

GEAR 2030 has defined the main issues involved in maintaining the international competitiveness of the European automotive industry and addressing the transformation of the industry's structure, and is conducting research and development and shoring up production capacity for next-generation batteries in preparation for electrification policies. It is also involved in the large-scale development carried out by the European Union and other member countries on connected and automated driving (CAD), as well as in addressing global warming and health issues such as the reduction of CO_2 emissions.

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 2018 ITS World Congress in Copenhagen 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 2018, there is unfortunately not enough space in this article to list all the individual initiatives being carried out by government organizations.

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