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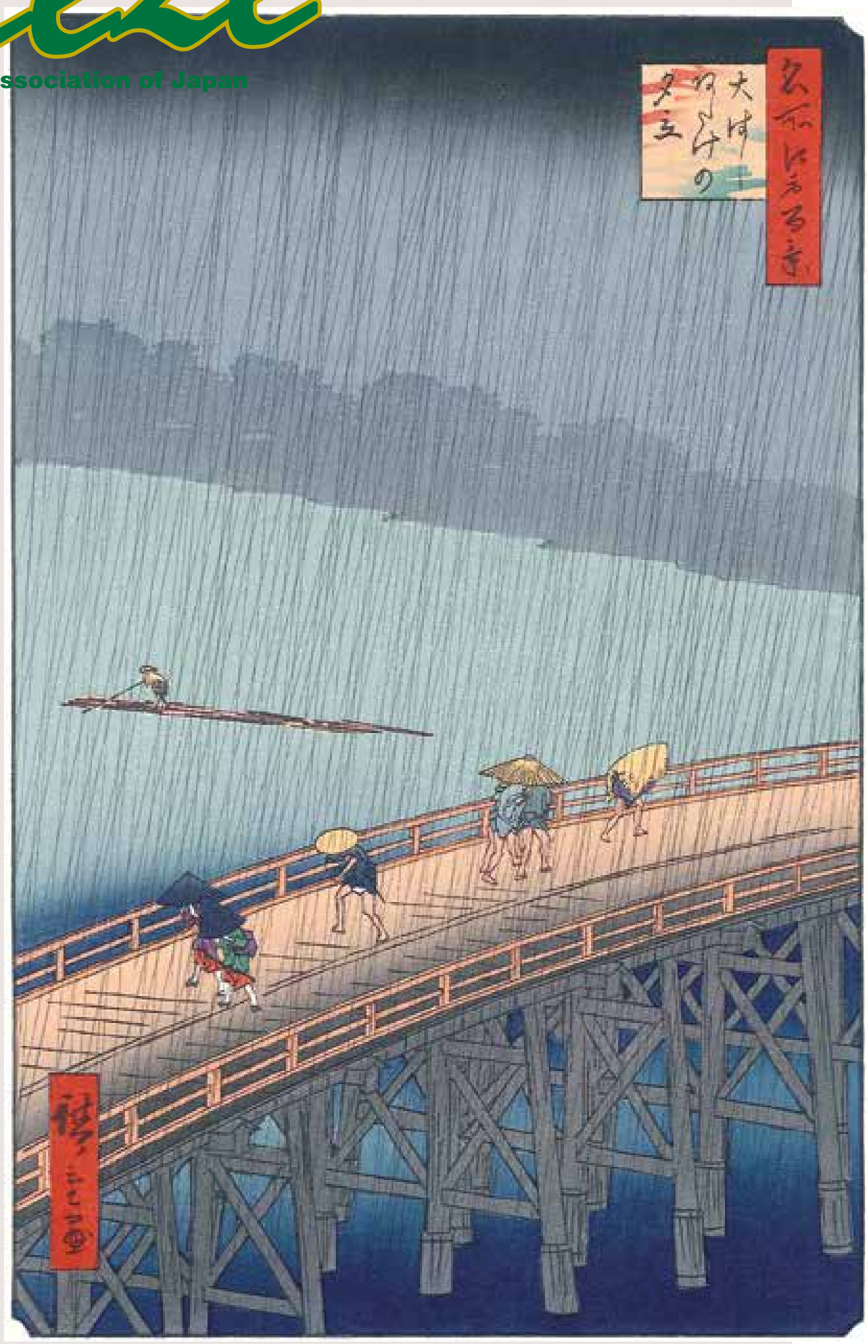

Special Feature

ICT for the Next Generation ITS

Phased ITS Development in Japan, Project in India, Automated Driving, SIP Auto Driving, Vehicle-to-Vehicle Comm., Vehicle-to-Pedestrian Comm., Infrastructure Radar System, Comm. Tech. Survey

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About the ITU-AJ

The ITU Association of Japan (ITU-AJ) was founded on September 1, 1971, to coordinate Japanese activities in the telecommunication and broadcasting sectors with international activities. Today, the principle activities of the ITU-AJ are to cooperate in various activities of international organizations such as the ITU and to disseminate information about them. The Association also aims to help developing countries by supporting technical assistance, as well as by taking part in general international cooperation, mainly through the Asia-Pacific Telecommunity (APT), so as to contribute to the advance of the telecommunications and broadcasting throughout the world.

Towards the Realization of Next-Generation ITS

Shin Morishita
Director of New-Generation Mobile Communications Office
Land Mobile Communications Division, Radio Department, Telecommunications Bureau
Ministry of Internal Affairs and Communications (MIC)

1. Introduction

In recent years, efforts have been made worldwide with the aim of realizing automated driving systems. In Europe and the United States, work has begun on projects to develop technology related to automated driving, and there is growing competition in development efforts, with major car manufacturers actively developing new technologies and announcing product development plans.

For the Intelligent Transport Systems (ITS) in Japan, car manufacturers are working on the introduction of driver support systems to perform functions such as controlling a car's speed and its distance from the car in front or applying the brakes in order to reduce collision damage.

In Japan, work has now begun in earnest with the aim of realizing automated driving systems such as the next-generation ITS. Some of these efforts are introduced below, and as you will see, they will be widely used in practical systems within a few years.

2. Efforts aimed at realizing the next-generation ITS

(1) Introducing the world's first cooperative ITS using vehicle-to-vehicle communication

Previously, car manufacturers implemented practical systems that enabled cars to autonomously avoid collisions and keep within traffic lanes by making use of car-mounted equipment such as radars and cameras. Autonomous driver support functions of this sort have the merit of enabling vehicles to perform detection without relying on any external capabilities in, for example, the road infrastructure or neighboring vehicles. On the other hand, they are only able to detect things that are within view of the vehicle, and when using equipment such as a camera as the detection means, the detection performance can be affected by ambient conditions such as the weather or the amount of daylight. Therefore, to provide autonomous driver support, it is expected that use will be made of systems that prevent collisions and the like based on mutual communication of information such as the vehicle's position and speed by wireless connections with other vehicles on the road, roadside equipment and the like (vehicle-to-vehicle and vehicle-to-infrastructure communication).

This sort of system is called "cooperative ITS" because it has the effect of preventing collisions and the like through a process of mutual cooperation between vehicles. At the Ministry of Internal Affairs and Communications, it was decided to make part of the 700 MHz band (755.5–764.5 MHz) available for this purpose.

In October last year, the ITS Connect Promotion Consortium was founded with a view to creating practical 700 MHz band systems, and Toyota Motor Company plans to adopt this technology in some of its new models for the domestic market starting this year. This is the world's first practical embodiment of cooperative ITS using vehicle-to-vehicle communication, and this trend has also drawn international attention.

(2) Efforts aimed at the realization of automated driving systems

In the Cabinet Office's Council for Science, Technology and Innovation, the Strategic Innovation Promotion (SIP) program was set up as an interdisciplinary and interdepartmental initiative to select issues that are essential for society and important for Japan's economic and industrial competitivenes.

One such issue is the development of an automated driving system, which is an important goal that we hope to have reached by 2020 through cooperation between industry, government and academia.

Regarding the technology needed to support automated driving systems of the future that will require advanced driving control, the Ministry of Internal Affairs and Communications is working with related government departments over a 3-to-5-year period on a project to implement advanced cooperative ITS and the like through vehicle-to-vehicle, vehicle-to-infrastructure and vehicle-to-pedestrian communication ("Establishment of next-generation ITS using ICT"). In this project, we are also developing an infrastructure radar system that uses 79GHz band high-resolution radars installed at the roadside to monitor road junctions and other locations from above in order to detect things like pedestrians and bicycles and report their presence to passing vehicles.

3. Lecture meeting: "ICT for the Next Generation ITS"

Since last year, the Ministry of Internal Affairs and Communications has been holding lecture meetings ("ICT for the Next Generation ITS") to introduce the results of our ITS-related research and development and allow other people who are actually involved in ITS-related organizations and/or corporations to deliver presentations on their latest efforts.

This year, the event was held on the afternoon of March 6th (Friday) at the Tokyo Nikkei Hall.

Thanks to the cooperation of the speakers, detailed write-ups of this event's lectures can be found elsewhere in this special feature edition.

Phased ITS Development in Japan

Hajime Amano
ITS Japan President & CEO

1. Introduction

ITS in Japan started with a comprehensive plan compiled in 1996, where 9 priority areas were identified. Since then, the public and private sectors have worked together to achieve successful nationwide implementation (Figure 1). During this period, telecommunication and electronic control technologies started to develop dramatically, and we took a somewhat technology-oriented approach when applying new technologies to transportation.

We then shifted to an objective-oriented approach to deploy integrated systems such as connected vehicle systems for safe, environment friendly and convenient mobility. We call this period the 'second stage' to distinguish it from the earlier one (called the 'first stage').

Today, we need to provide ITS that contributes to enhancement of the transportation network as a foundation for solving the fundamental challenges facing our society — aging population, global warming, sustainable energy supply, and safety against natural and manmade disasters. In this way, the development and deployment of ITS in Japan and its penetration into Japanese society have evolved through various phases towards a wider perspective of transportation. Japan has hosted ITS World Congresses in Yokohama (1995), in Nagoya (2004) and in Tokyo (2013). These international events marked important milestones for us to step forward with close collaboration among government, academia and industries (Figure 2).

2. Societal challenges and transportation systems

Japanese society is rapidly ageing. It is said that by the 2050s, 40% of Japan's population will be at least 65 years old. It will no longer be practical to set a fixed age threshold above which everyone is supported by social welfare. Instead, we should pay attention to diversity of individuals, and provide them with opportunities to participate in social activities as long as their physical conditions allow. We need to balance the autonomy of people with the support they receive from their families, communities and social welfare systems. To realize such a framework, it is vital to ensure people have sufficient autonomy to move to wherever they want, whenever they like. In particular, in rural areas that are heavily dependent on personal transport, it must be easy for people to access advanced driving assist systems and financially sustainable public transportation.

Japan is also exposed to serious natural disasters. While it is not possible to stop natural disasters from happening, we have made preparations for the timely provision of information and prompt, effective transportation for rescue operations in order to minimize the impact of these disasters on humans. Having suffered the Great East Japan Earthquake, we know how vulnerable our modern society can be. The impact of this disaster spread immediately. Serious power shortages affected the entire country, and lost production led to a shortage of parts for the manufacturing sector that had a serious effect on global economic activity. On the other hand, technical innovations and changes in people's behavior showed that Japan has potential for a sustainable future.

Figure 1: Comprehensive ITS plan in Japan (1996)

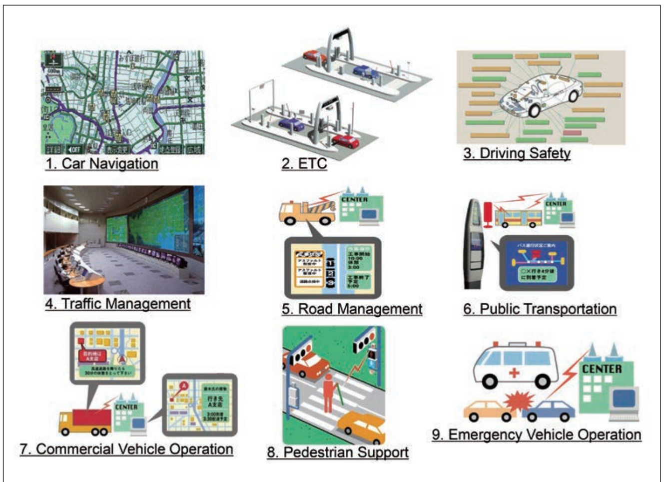


Figure 2: Deployment, and New Challenges

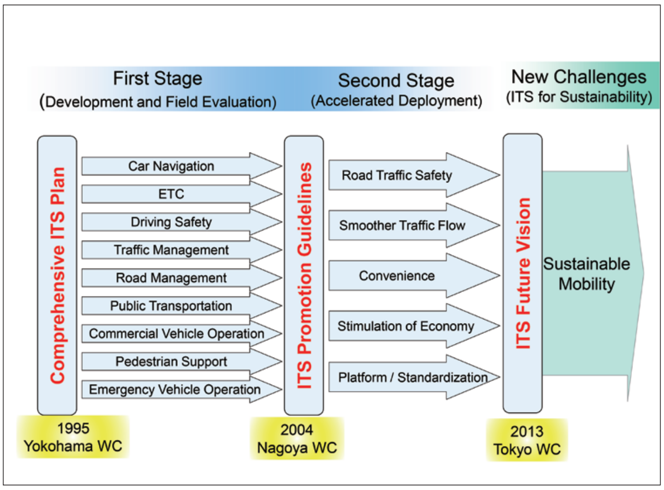
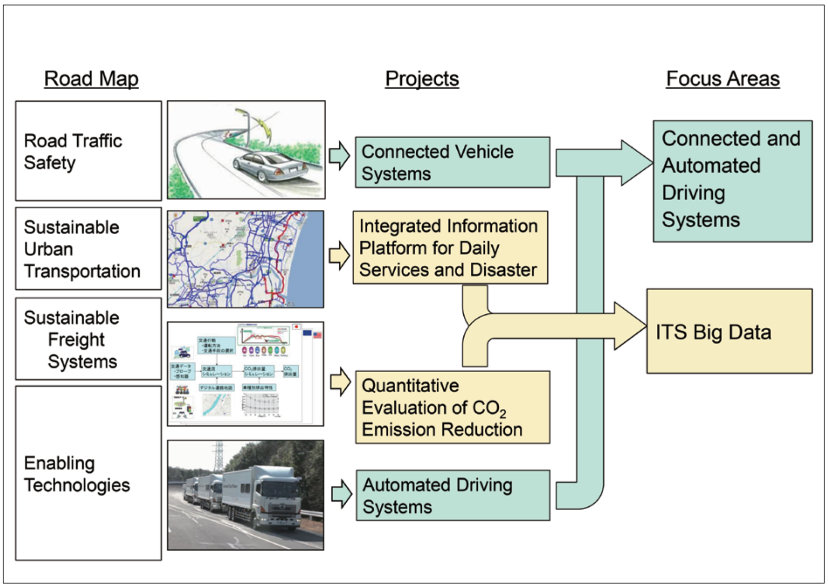


Figure 3: National ITS project



3. Technology and social change

In *Pioneering Projects for Acceleration Social Return* (2008–2012), we conducted field evaluation tests of integrated ITS systems in selected model cities under the supervision of the Council for Science and Technology Policy of Japan. This project has helped to cultivate technologies such as telecommunication, information processing and automated control. At the end of the project, we identified two major areas for further work. Those are applications of ITS Big Data in transportation, and connected/automated driving systems. (Figure 3)

We took those as the main topics at the ITS World Congress Tokyo 2013 and the following ITS World Congress in Detroit. These were also listed among Japan's national strategies, and are the subject of various new projects. We find the same topics in the European Commission's project *Horizon 2020: the Framework Programme for Research and Innovation (2014-2020)*, and in the ITS Strategic Plan (2015–2019) of the US Department of Transportation. Innovative technologies have already penetrated into our daily lives and changed society in various ways. Crowd sourcing allows huge volumes of data to be generated via high speed mobile communication. The separation of network infrastructure and mobile terminal businesses from service provision has resulted in the creation of new business opportunities for a new breed of entrepreneurs. Electrification of automobiles does not simply mean diversion of energy sources but also means that automobiles play roles balancing demand and supply in 'smart grid' systems.

When faced with the serious challenges of the Great East Japan Earthquake, we realized how important it is to have social capitals fostered over many years in local communities. The ability of people to survive and help each other has been significantly enhanced, and compensates for the lack of capacity of public authorities to rescue people in devastated areas. In addition to volunteers working on-site, it was also found that useful voluntary support for affected people could be provided from distant cities via information networks.

To design transportation systems for the next generation, it is important to take an integrated approach that incorporates both technological innovations and social implications.

4. Activities at ITS Japan

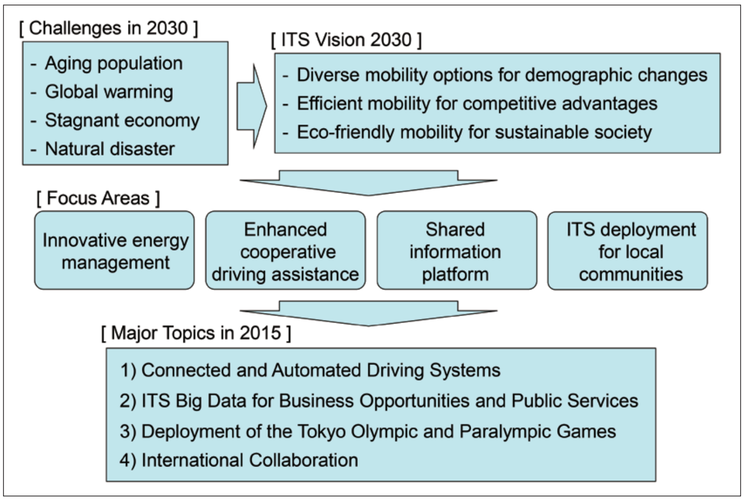
ITS Japan has focused on 1) connected and automated driving systems, 2) ITS Big Data for business opportunities and public services, 3) deployment of ITS technology for the Tokyo Olympic and Paralympic Games, and 4) international collaboration. The experience we have gathered through activities at ITS Japan, such as enhanced digital road maps and Quasi-Zenith Satellite and cooperative driving assist systems, is integrated in these areas (Figure 4). We are actively engaging in a national project on automated driving systems called the *Innovation of Automated Driving for Universal Services (SIP-adus).*

As an application of ITS big data, we have been providing route guidance information during rescue and recovery operation from natural disasters since the Great East Japan Earthquake. Based on this experience, we are participating in disaster drills by providing a variety of related information to drivers, integrating data from both the public and private sectors. Regarding open data, since best practices are often found in municipal government level under close collaboration with local ICT service providers, we are also working with them to share experiences of those activities and to promote ITS deployment initiatives by local government agencies.

5. For the future

We are already living in an information network society, where well-informed individuals play active roles to recognize and solve social challenges and to balance benefits for individuals and public interests. Strong leadership across the boundary of industrial sectors, academic disciplines and jurisdictions is vitally important for drawing up ground designs, developing action plans and coordinating individual efforts.

Figure 4: Approaches by ITS Japan



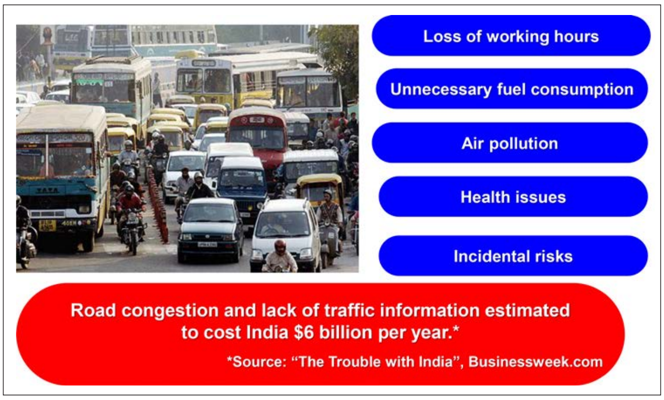
ITS Project in India

Tsutomu Tsuboi
General Manager
President Office
Nagoya Electric Works Co,. Ltd.

1. The traffic situation in an emerging country (India)

In recent years, traffic congestion problems have become increasingly severe not only in Japan but also in Asian countries that are continuing to undergo significant development. This is especially so in India, which has an economic growth rate of 5–7% and the world's second largest population, and where the economic losses caused by traffic congestion amount to approximately $6 billion per year.* Traffic congestion not only causes lost working hours but also leads to large economic losses through unnecessary fuel consumption, as well as air pollution and its implications for public health. (Figure 1) The root causes of congestion are increasing vehicle transportation coupled with delays to the improvement of the road infrastructure, which is a common issue in emerging countries where development must be promoted without standing in the way of economic growth.

Figure 1: Traffic in India



2. Japanese technology and Indian cooperation

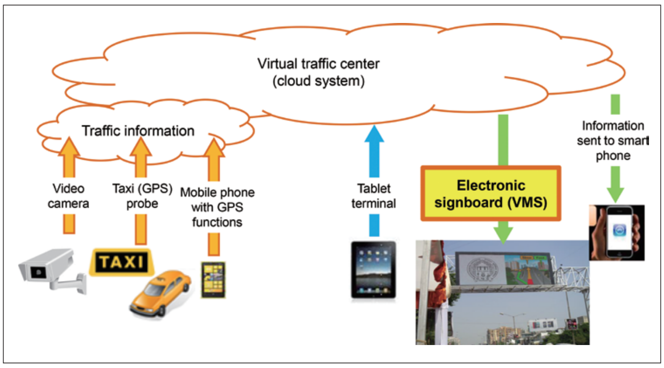
With the aim of improving the traffic conditions in India, a special purpose company (SPC) has been established by Nagoya Electric Works (a long-established manufacturer of electronic signboards installed alongside roads) and Zero-Sum (a venture capital business with experience in electronic map software and system software for working with traffic congestion information aggregated from traffic information). This SPC started up a project in October 2014 to test the alleviation of congestion by displaying detour route information on a display panel as a way of providing traffic information to the public. The project was targeted at the city of Ahmedabad in Gujarat, which is one of India's fastest developing cities, and was particularly aimed at alleviating congestion in the severely congested new town to the west of the river that flows through the city. (Figure 2) In the new town, half the traffic jams are caused by cars headed for the city center during the rush hour, but since there is no way of providing drivers with information such as which streets are passable or what detours are available, it has not been easy to take remedial action and so the traffic jams have continued to be a chronic problem.

Figure 2: Where the system is installed

3. ITS system configuration

In this project, our aim was to alleviate these traffic jams by using Japanese ICT (information communication technology). In other words, we aimed to construct a system that allows information to flow in real time by ascertaining the state of traffic congestion from roadside cameras and taxi service information (probe data) and predicting the flow of traffic. The system includes 14 cameras to monitor the traffic conditions, and four electronic signboards to display traffic information. (Figure 3) This project was implemented with the support of the Japan International Cooperation Agency's (JICA) program of assistance for overseas deployment of SMEs. A unique point of this project is that it employs a public/private partnership (PPP) model whereby half the display area of the traffic information signboards is used to carry regular advertising to provide revenue for the maintenance and operation of the system. This is a sustainable model that allows the business to grow in financially impoverished regions. (Figure 4) The system also uses Internet-based cloud services so that it can ascertain and manage the situation in any location without providing the sort of traffic control centers that we have in Japan, allowing costs to be reduced to approximately one quarter. The police are also provided with tablet terminals so that they can check the traffic conditions and, if necessary, supply the system with traffic information from their current location or even alter the

■ Figure 3: ITS System Configuration



■ Figure 4: PPP model signboard displays

displays on the electronic signboards, thereby allowing the system to adapt to the local situation.

4. ITS system operation

The system introduced in this project represents a significant breakthrough, combining Japanese hardware technology with an operation system tailored to the local situation. For example, congestion is often caused by festivals, which are not uncommon in India. To cope with these occurrences, the system is provided with a menu that allows information to be displayed by tablet terminals on the electronic signboard by performing simple operations, allowing it to be operated in close harmony with the local situation. As an introduction to this system, a grand opening ceremony was held in Ahmedabad in October last year, attended by over a hundred people including local mayors, commissioners, police chiefs, the director of JICA India and government ministers. (Figure 5) These activities are also supported by the Japan-India ICT Working Group, which is led by Japan's Ministry of Internal Affairs and Communications, and were reported at a workshop held in Delhi last December. (Figure 6)

5. Building smart cities in India

India has launched a project aimed at building a hundred "smart cities" centered on its existing major cities, including smart mobility measures aimed at implementing a road infrastructure that reduces traffic congestion. The Intelligent Transport Systems (ITS) project deployed in Ahmedabad has also attracted attention as a possible model for smart cities. It has been visited by observers from every state in India, and has been widely reported in the newspapers, on TV and in other media, reflecting the high expectations of this technology. (Figure 7) By promoting cooperation between Japan and India, these activities will not only help to solve the problems facing India's major cities, but will also lead to initiatives aimed at resolving environmental issues on a global scale, so the potential benefits and importance of this project are enormous. We are proud to do whatever we can to ensure that these benefits are realized.

■ Figure 5: Project Opening Ceremony (October 2015)

■ Figure 6: Japan-India ICT Working Group, December 2014

■ Figure 7: One of the electronic signboards

* Businessweek.com: "The Trouble with India", http://www.bloomberg.com/bw/stories/2007-03-18/the-trouble-with-india

ICT for ITS and Automated Driving: Honda's Effort

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1. Introduction

Over the last few years, a growing number of driver assistance systems using on-board sensors have been brought into practical use. Research and development of automated driving technology for practical applications have also been gaining momentum worldwide at organizations including Google. Although this research is currently focused on autonomous systems using on-board sensors, the use of V2X systems based on wireless communication technology will hold the vital key for future functional advances. This article introduces Honda's efforts related to these technologies.

2. Honda's environmental and safety vision

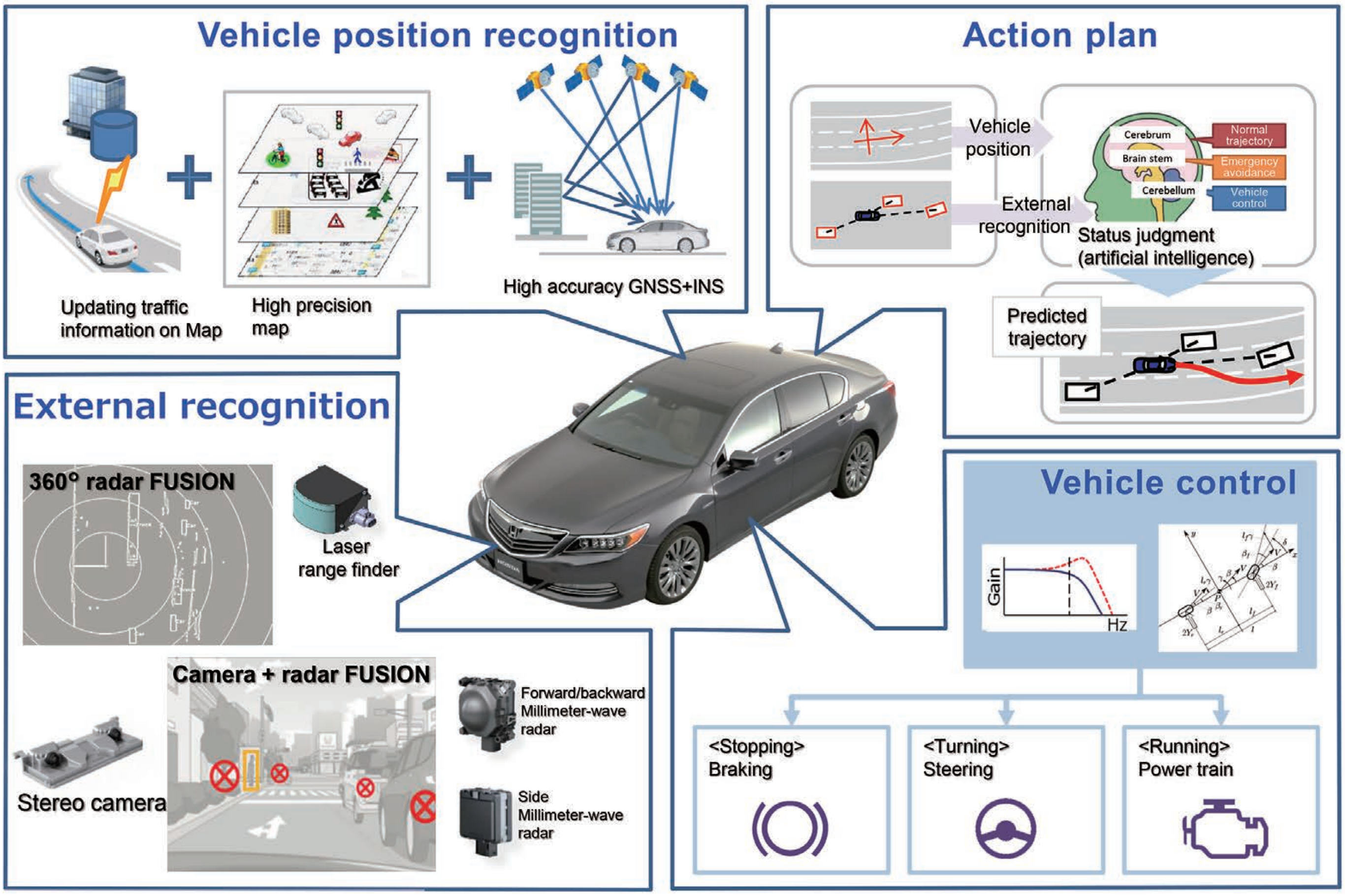
Honda's goal is to realize "the Joy and Freedom of Mobility" and "a Sustainable Society where People Can Enjoy Life". We consider that driver assistance systems and automated driving systems are essential to realize "the Joy and Freedom of Mobility" in safe, secure, and comfortable manner. We are conducting active research and development with the aim of developing practical applications as soon as possible.

3. Expectations of ITS and automated driving technology

Various research organizations have reported analysis results showing that over 90% of traffic accidents are caused by driver error. In Japan, 52.7% of traffic fatalities in 2013 were people aged 65 and over. A survey report by the Cabinet Office revealed that the economic loss of traffic accidents was ¥6.3 trillion in 2009.

Figure 1: Honda SENSING

Figure 2: Automated driving system configuration example



According to the information economy innovation strategy of the Ministry of Economy, Trade and Industry, 3.2 billion hours are lost every year in traffic congestion, which equates to economic losses of ¥9 trillion. It is hoped that these statistics can be improved by working towards an accident-free society, enhancing the flow of traffic to relieve congestion and improve punctuality, and reducing the energy consumed by transportation.

4. Current status of driving support technology

Last year, Honda announced a new advanced driver assistance system called “Honda SENSING.” This system supports driving not only in the forward direction but also in reverse and sideways. Honda SENSING enables the detection of pedestrians in addition to conventional collision avoidance braking. Other new technologies have also been added, including Pedestrian Collision Mitigation Steering System, Road Departure Mitigation (RDM) system, Adaptive Cruise Control (ACC) with Low-Speed Follow, and Traffic Sign Recognition. The driving environment recognition technology used to implement each of the forward safety systems is configured by a sensor fusion technology incorporating a 77 GHz electronic scanning millimeter-wave radar and a monocular color camera. To detect objects in complex situations, the camera recognizes the attributes and size of target objects, and the radar recognizes the position and speed of the target objects while traveling at high speed. Compared with conventional systems, the radar detection range is expanded, the camera resolution is enhanced (equivalent to HD television), and the computation performance of the system is improved. As a result, the system’s recognition performance has been improved approximately fourfold compared with a conventional system. These new technologies are being sequentially introduced starting with Honda's new Odyssey and Legend models.

Moreover, with respect to Honda’s “Green Wave” driving support system, which makes use of traffic signal information, we are working on large-scale demonstration and testing of the system by Honda employees on public roads in Utsunomiya city, Tochigi prefecture, and we are monitoring its effects on changes in safety-related vehicle behavior, improvement of fuel consumption, traffic flow and so on. (Figure 1)

5. Current state of automated driving technology

With regard to technical development, auto manufacturers are working independently in some areas such as vehicle position recognition, road environment recognition, action planning and vehicle control, while in other areas they are cooperating to tackle issues together. Vehicle position recognition technology

Figure 3: Honda's work on automated driving support

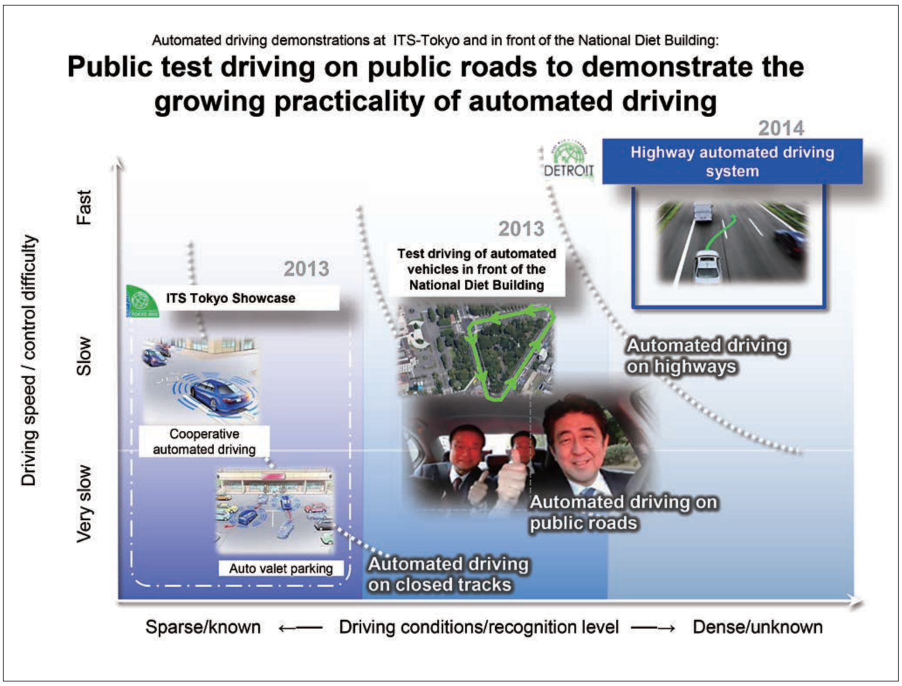
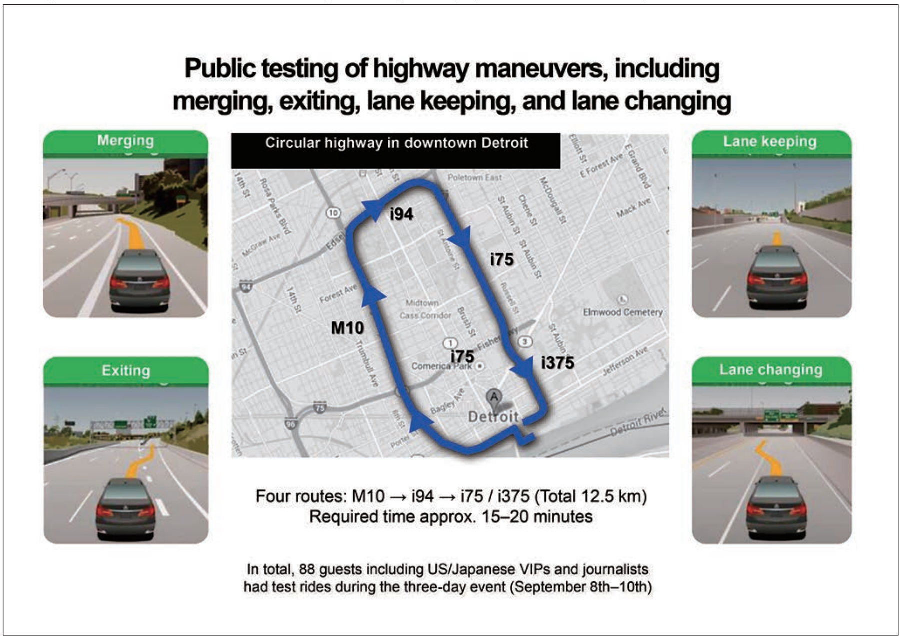


Figure 4: Automated driving on highway (Demonstration)



(localization) for car navigation systems has been already put to practical use. However, automated driving requires recognition technology that is more accurate and combines macro-scale vehicle position recognition (to recognize the vehicle's current position on the predicted route between the starting point and destination) with micro-scale vehicle position recognition so that the vehicle can recognize multiple lanes and choose the correct one for going straight or turning left or right at intersections, and so on. External recognition technology must be able to identify objects up to a required distance over a 360° range around the vehicle by using a complex combination of sensors based on various different detection principles that have already been put to practical use in the Advanced Driver Assistance System. An automated driving action plan is produced based on the results of these vehicle position recognition external recognition. This action plan (e.g., trajectories for normal driving and emergency avoidance) is formulated based on comprehensive perception and judgment of the position, orientation and speed of one's own vehicle and other vehicles, and other road environment conditions (such as the presence of obstacles). (Figure 2)

Honda's activities related to automated driving technology include demonstrations of automatic valet parking and cooperative automated driving in a restricted area at ITS Tokyo in 2013. In November of the same year, we carried out test drives with VIPs on an ordinary road in front of the National Diet Building. As the Honda showcase at ITS Detroit in 2014, we gave a demonstration of automated driving including automatic merging, branching, and lane change on a highway near Cobo Hall, in which 88 people were involved. (Figure 3,4)

6. Summary

When implementing automated driving systems, there are a diverse range of technical and other issues that need to be addressed. To overcome these issues, it is possible to consider vehicle position recognition, external recognition, action planning, vehicle control and the like as competitive areas of each company. On the other hand, although a dynamic map infrastructure needs to be developed to solve these issues, there is a limit to what can be achieved by individual companies working independently. So there is also a need for cooperative efforts involving not only the automotive industry, but also the communications industry and relevant government agencies. Similarly, it may become necessary to cooperate in order to prepare facilities for verification testing of functions such as V2X and HMI.

As legal and social initiatives for the realization of automated driving vehicles, it is important to achieve consistency with current international road agreements, and in particular to clarify assignment of roles and division of responsibilities between the driver and the system. To encourage the spread of this technology, it will also be necessary to promote international standardization efforts in partnership with Europe and the United States, to engage with social campaigns, and to verify the acceptability of this technology to other road users in a mixed driving environment.

SIP Automated Driving System

— *SIP Automated Driving for Universal Service (SIP-adus)* —

Seigo Kuzumaki
CSTO Secretary
Product Planning Division
Toyota Motor Corporation

1. Introduction

In the 2014 fiscal year, a Cross-Ministerial Strategic Innovation Promotion Program was established as one of the flagship functional enhancements of the Council for Science, Technology and Innovation. In this program, the Council for Science, Technology and Innovation selects issues that are indispensable to society and have an important bearing on Japan's economic and industrial competitiveness, and engages with these issues at every stage from basic research to practical implementation and commercialization by crossing the boundaries between different disciplines and government departments. Ten themes were selected for the 2014 business year, including automated driving systems, and ¥50 billion was earmarked by the cabinet office as expenses to promote innovative creativity in science and technology.

A program director (PD) was appointed to address any issues that arose, and research and development is being promoted based on the assessments and advice of a governing board consisting of expert members of the Council for Science, Technology and Innovation. In the SIP automated driving system (SIP-adus), a promotion committee was established under the supervision of PD Hiroyuki Watanabe of Toyota Motor Corporation. This committee includes members from various bodies such as the Cabinet Secretariat, National Police Agency, Ministry of Internal Affairs and Communications, Ministry of Economy, Trade and Industry, the road and vehicle departments of the Ministry of Land, Infrastructure, Transport and Tourism and other public and private organizations centered on the motor industry, together with journalists and experts from universities and research organizations, and is promoting discussions and research on issues related to the realization of automated driving systems that need to be addressed at a national level.

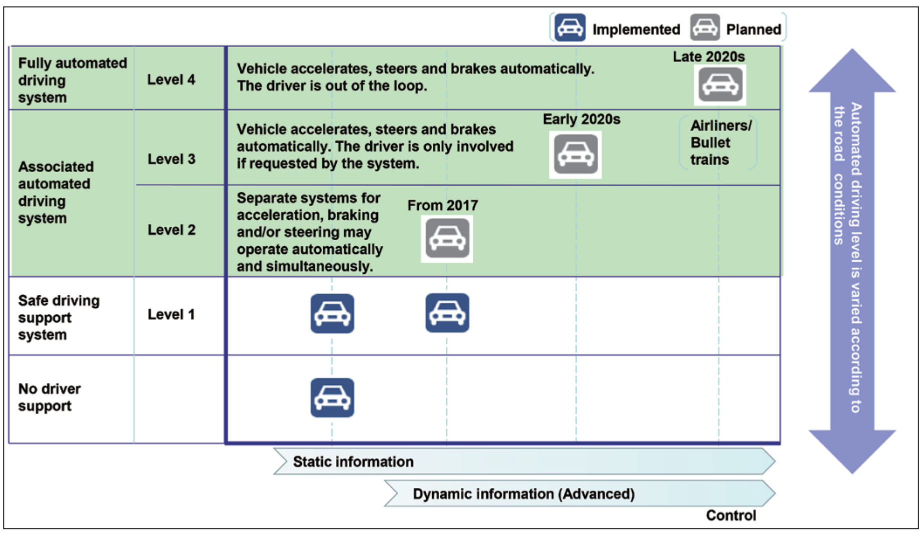
2. The aims and exit strategy of SIP-adus

When starting up SIP-adus, reducing the number of traffic accident fatalities was set as the highest-priority after a discussion of Japan's reasons for promoting automated driving systems. This is because while Japan would fail to meet the national target of becoming the world's safest country with less than 2500 fatalities occurring within 24 hours of a traffic accident per year by 2018, it is expected that automated driving systems will have greater potential for reducing traffic accidents by supporting drivers and avoiding danger.

In addition to this sort of social significance, it is also of great industrial significance in that it will create new services and industries by making Japan's motor industry more competitive and expanding the markets of related industries. It also has the secondary goal of hastening the implementation of an automated driving system.

There is also a third goal, which is related to another core purpose of SIP: to realize a next-generation urban traffic system in time for the 2020 Tokyo Olympic and Paralympic Games by engaging at all levels from basic research to practical implementation and commercialization.

Figure 1: Definitions of automated driving levels

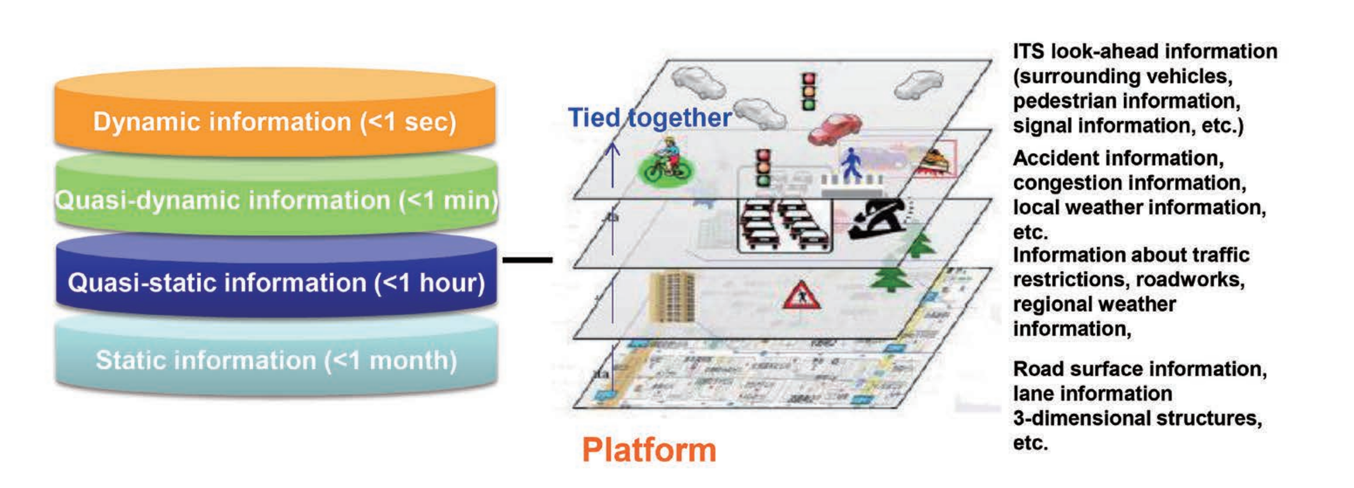


3. Definition of automated driving levels

When discussing automated driving systems, people often have totally different images of what they entail. On hearing the words "automated driving", some people might think of driverless cars, while others might think of cars equipped with technology that is already commercially available, such as the combination of Lane Keep Assist (LKA), Adaptive Cruise Control (ACC) and Pre-Crash Safety Systems (PCS).

For this reason, definitions of automated driving levels are currently under discussion at organizations such as the NHTSA and OICA. Since

Figure 2: Dynamic map



these discussions had only just begun when SIP-adus started, we defined four levels based on the NHTSA definitions. A characteristic of our definitions is that the automated driving level changes from one moment to the next according to the driver's intentions and the driving conditions. However, our level definitions are not set in stone, and are liable to be amended after further international discussions.

4. Scope of research and development area

Based on various announcements made by Google and car manufacturers about the development of automated driving systems, it can be seen that the core technologies of automated driving systems are intelligent technologies consisting of so-called on-board systems like vehicle sensors and control techniques. This raises the issue of deciding which areas should be tackled cooperatively by national projects, and which would be better left to private-sector competition.

Even only with on-board systems like the abovementioned combination of LKA+ACC+PCS, cars are still capable of automated driving to quite a considerable level. However, to cope with more complex environments and ensure greater safety, the limitations of on-board systems need to be complemented by using accurate maps and look-ahead information obtained from ITS. These are thought to be issues that need cooperative engagement between related parties including the government, rather than by individual motor companies.

Also, as vehicles become more intelligent and their interactions with drivers become more complex, users are more likely to be confused and meet with accidents if every company implements a different human-machine interface (HMI). It is therefore also necessary to create industry-wide guidelines for HMI.

Furthermore, when we reach the era of "connected" vehicles where ITS and communication technology is used to acquire information about traffic congestion or about other vehicles, information security will also become a major concern. Malicious cyber attacks may pose threats not only to vehicle safety but also to people's trust in the traffic systems themselves. Therefore, information security is also an important concern requiring mutual cooperation between industry and Japan as a whole.

In addition to these challenges, it was decided that work on SIP-adus should include the development of an accident database and a methodology for simulating the effectiveness of traffic accident reduction as a national platform for the reduction of traffic fatalities and road congestion.

Furthermore, based on the idea that vehicles are global commodities requiring global cooperation, we have tried from the very beginning to communicate with overseas researchers in order to promote social acceptance of automated driving systems.

For the 2020 Tokyo Olympics and Paralympics, we are also cooperating with Tokyo in order to establish a next-generation urban transportation system and improved accessibility.

5. Technology and communication requirements of automatic driving systems

For automated driving, a vehicle must be able to estimate its own position accurately and determine the path of the road upon which it is driving. To achieve this, it is necessary to develop not only on-board sensors such as cameras and radars, but also precise maps and geolocation systems. Also, driving with on-board sensors alone is a bit like driving in complete darkness with just the headlights on, which is not as safe and may even be impossible in severe weather conditions or driving environments. This is complemented by making effective use of technologies such as ITS and GPS.

In other words, an automated driving system cannot be implemented with a single sensor, but can be implemented using diverse information from different complementary systems.

The precise maps needed for this purpose are nothing like the sort of maps used for ordinary car navigation systems. First of all, for automated driving, a vehicle must know how much space there is on the road for it to run on. Although it is of course possible to navigate with the white lines on the road, a vehicle must be able to determine where it can go to avoid obstacles such as parked cars or fallen objects in the road, or to avoid collisions with oncoming vehicles. For this purpose, three-dimensional road profile information is needed in order to distinguish between the curb and the roadside. It is also necessary to have other information such as lane closures and the locations of road works.

In addition to this static and quasi-static information, it is also necessary to have time-varying dynamic information. This includes quasi-dynamic information such as accident information, traffic information, and weather information including the extent of flooding and the like. An important source of dynamic information to complement the information from on-board sensors is ITS look-ahead information obtained by vehicle-to-vehicle, vehicle-to-infrastructure and vehicle-to-pedestrian communication. This information should be accurately linked to positions on the map. A database that includes all this static, quasi-static, quasi-dynamic and dynamic information is called a dynamic map. A dynamic map is a useful source of data not just for automated driving systems but for all vehicles, and is regarded as indispensable for vehicles to drive safely and comfortably.

Also, the three-dimensional road data profile is not only applicable to automated driving systems, but is also very useful for applications such as the maintenance of social infrastructure, disaster prevention/mitigation, and personal navigation. This means it will help to reduce the cost of producing precise maps, and will provide diverse information services in the future. In the SIP-adus project, we are willing to spearhead the construction of this database.

6. Using communication systems to reduce traffic fatalities

Finally, I will discuss how communication systems can be expected to reduce the number of traffic fatalities. As mentioned above, no matter how advanced the on-board sensors are, since they are mounted on a vehicle there will inevitably be blind spots at intersections or junctions with poor visibility. Currently, about half of all traffic fatalities in Japan occur at or near intersections. To reduce these accidents it is necessary to use not only on-board sensors but also ITS look-ahead information from sources such as vehicle-to-vehicle, vehicle-to-infrastructure and vehicle-to-pedestrian communication.

Meanwhile, there are still many other problems to be solved. In the SIP-adus project, we are establishing protocols for vehicle-to-vehicle and vehicle-to-infrastructure communication, we are developing systems that use direct communication via dedicated terminals and communication via mobile phone networks, and we are working on the development of a 79 GHz high-resolution radar that can detect obstacles such as people and other vehicles.

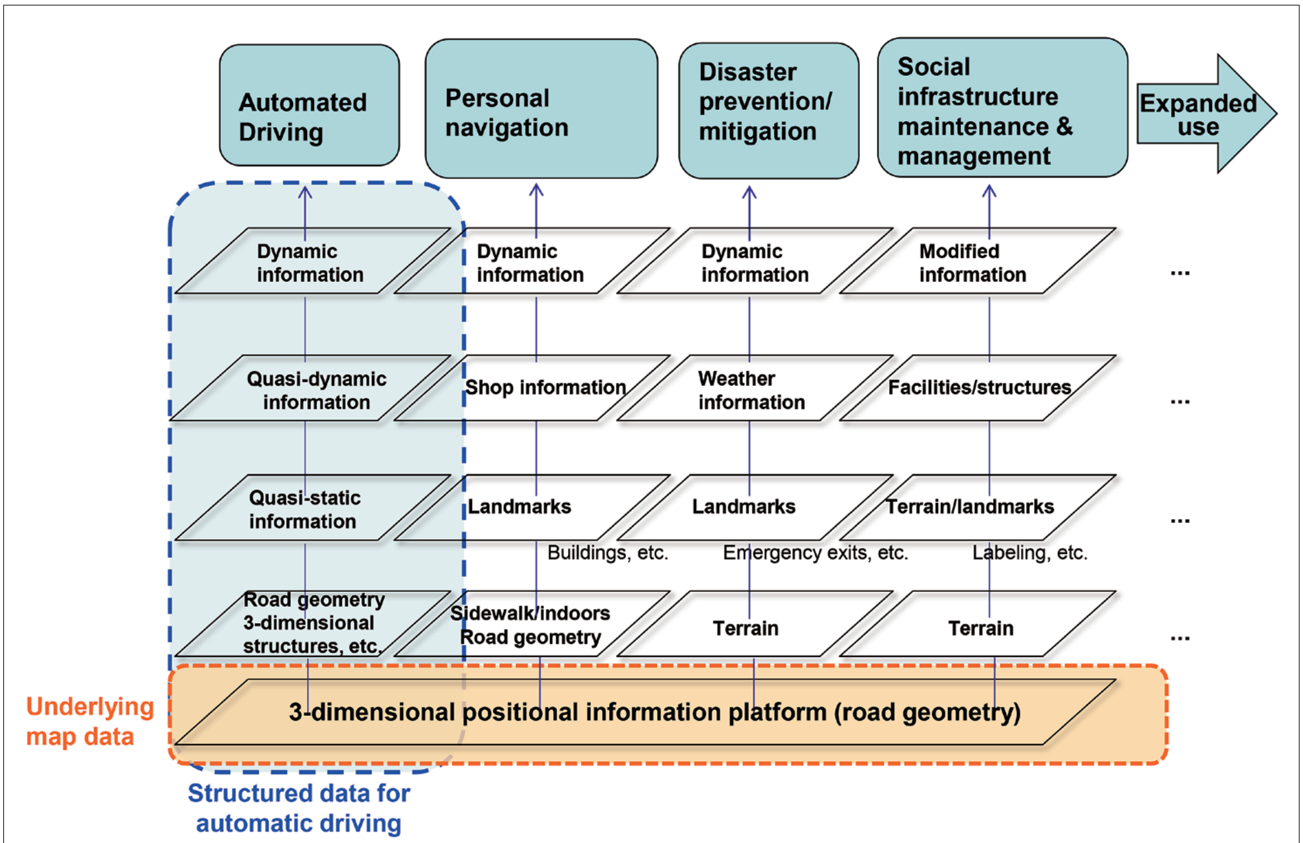
Details of these efforts will be described later by the people responsible for each initiative.

7. Concluding remarks

All the interested parties are currently engaged in research and development to implement an automated driving system, but our goal is to realize a next-generation traffic system where accidents are a thing of the past. To reduce the number of accidents, it is still necessary to treat people, vehicles and traffic environments as a single ensemble.

We are not aiming to build a future where humans have nothing to do, but we hope that our efforts will soon provide people around the world with safe, stress-free transport by complementing with people, vehicles and traffic environments.

Figure 3: Using base map data



Next-generation ITS to Support Information Communication

— *The development of vehicle-to-vehicle and vehicle-to-infrastructure communication technology needed by automated driving systems* —

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DENSO

1. Introduction

In 2013, the Japanese cabinet issued a declaration of Japan's intent to become the world's most advanced IT nation, stating that it would enable vehicle-to-vehicle, vehicle-to-infrastructure, vehicle-to-pedestrian and other modes of information exchange to be performed in a timely manner. It also stated its intention to implement an economical road traffic society that is both safe and environmentally friendly by using ITS (Intelligent Transport Systems) to avert traffic accidents and avoid road congestion, including the use of stored information and geospatial information such as map data and the locations of people and vehicles.

Wireless communication technology is an effective way of implementing a safe driving support communication system that reduces traffic accidents. It was realized that the reservation of a fixed frequency band in the region around 700 MHz vacated by the switch-over to terrestrial digital TV broadcasting would be suitable for this purpose because this frequency band exhibits favorable radio wave characteristics including diffractive and reliable information transmission, so the 760 MHz band was allocated for this purpose.

This paper introduces our verification trials of the vehicle-to-vehicle and vehicle-to-infrastructure communication technologies in the communication systems using the 760 MHz band according to the first edition of the ARIB STD-T109 standard published in February 2012.

2. Using ICT to establish the next generation of ITS

For the implementation and popularization of vehicle-to-vehicle and vehicle-to-infrastructure communication technology, the following issues should be addressed:

When the number of vehicles fitted with radio equipment is increasing, checks must be performed in real environments to verify that the communication performance is adequate for running applications. (Implemented as communication performance demonstration experiment)

During the period of increasing use, it will be necessary to ensure that sufficient capacity for radio communication by large numbers of vehicles is made available in the real world. We therefore made a plan to obtain diverse views and know-how for solving the problem through verification trials on public roads using large numbers of vehicles. The physical limitations are studied in conjunction with the simulations, and their differences are also considered. The experiments were performed in Nagoya and Yokosuka in consideration of the diversity of traffic environments in these two cities [1].

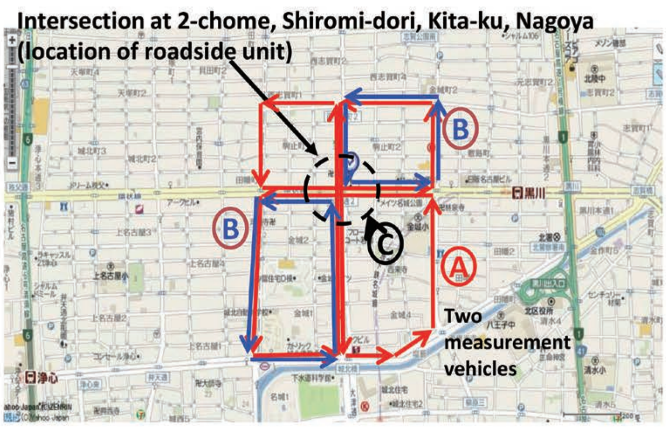
2.1 Communication performance verification trials

In these trials, dynamic evaluations of communication reliability were performed in Nagoya, and static evaluations were performed in Yokosuka. In Nagoya city, we used one set of roadside unit and 99 vehicles to perform tests ("dynamic evaluations") of vehicle communication performance while driving randomly under traffic conditions in the metropolitan area. In Yokosuka, we performed tests ("static evaluations") using one set of roadside unit and 79 sets of stationary vehicle-mounted radio equipment. These tests were performed in February 2015. Table 1 shows the scale of the Nagoya tests, and Table 2 shows the scale of the Yokosuka tests. Also, Figure 1 shows the test locations in Nagoya, and Figure 2 shows the test locations in Yokosuka. In these figures, Ⓐ, Ⓑ, and Ⓒ indicate the routes travelled by the measurement vehicle.

■Table 1: Scale of Nagoya experiment

Scale of experiment	Vehicles	Radio transmitters	
Fake emergency vehicle	1	1	Instructable
Instructable vehicles	15	15	Instructable
Measurement lease vehicles	2	2	Instructable
Subtotal	18	18	Instructable
Ambulance	32	32	Not instructable
Ordinary vehicles, commercial vehicles	34	34	Not instructable
Random driving vehicle	15	75	Not instructable
Subtotal	81	141	Not instructable
Total	99	159	

■ Figure 1: Location of Nagoya experiment

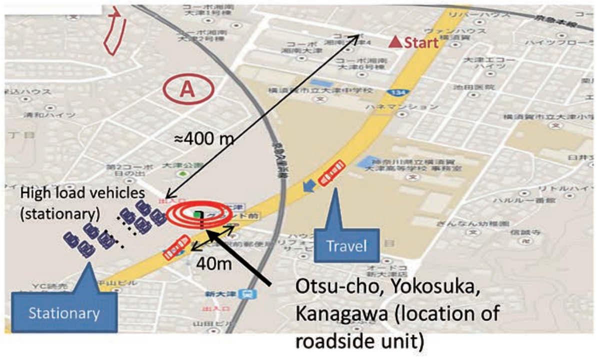


■Table 2: Scale of Yokosuka experiment

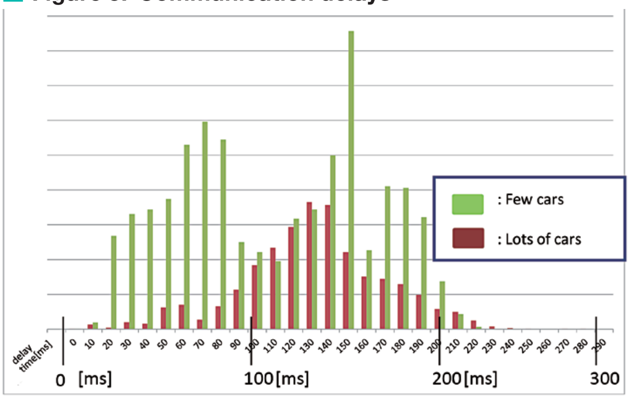
	Vehicles	Radio transmitters
Ambulance (or deputized vehicle)	2	2
Measurement vehicle	2	2
Heavy load prevention vehicle	15	75
Total	19	79

Roadside unit	No. of sets
No. of roadside unit	1
Total	1

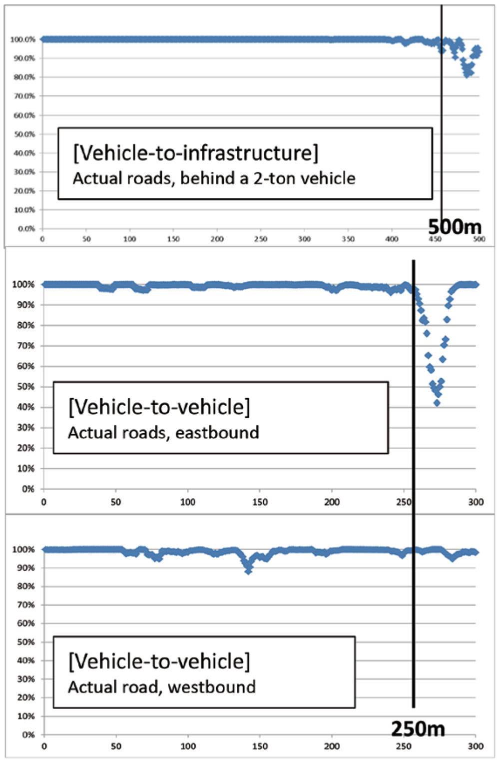
■ Figure 2: Location of Yokosuka experiment



■ Figure 3: Communication delays



■ Figure 4: Cumulative packet arrival rates



2.2 Results of checking the communication performance

The test results are considered by comprehensively judging the dynamic tests conducted in Nagoya and the static tests conducted in Yokosuka. Specifically, we evaluated the delays in communication and the packet arrival ratio as the number of vehicles was increased.

The communication delays are shown in Figure 3. Despite the increasing number of devices, the majority of them were still able to communicate within 0.3 seconds. We also achieved cumulated packet arrival rates within the assumed ranges for vehicle-to-infrastructure communication up to approximately 500 m, and for vehicle-to-vehicle communication up to approximately 250 m.

3. Future work

In the future, we will continue to study the communication techniques used in cooperative automated driving systems.

4. Conclusion

This technology is the result of research and development commissioned under the Ministry of Internal Affairs and Communications program to establish next-generation ITS using ICT, which is part of the research and development relating to SIP (the cross-ministerial Strategic Innovation Promotion program) and automated driving systems.

REFERENCES

[1] Denso Corporation, et al.: "Development of vehicle-to-vehicle and vehicle-to-infrastructure communication technologies for automated driving systems," Lecture & Exhibition: ICT for the Next Generation ITS, http://mic-its-conference-2015.net/en.html, March 2015

Cover Art

Meisho Edo Hyakkei Ohashi atake no yudachi

(Sudden Shower over Shin-Ohashi bridge and Atake, from the series One Hundred Famous Views of Edo)

Utagawa Hiroshige (1797-1858)

Woodblock print:
Courtesy of Sakai Kokodo Gallery

Development of Vehicle-to-Pedestrian Communication Technology

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1. Introduction

Aiming to reduce the number of traffic fatalities in Japan to under 2,500 by the year 2018, this project contributes to Japan's national objective of becoming the world's safest traffic society by the year 2020. As the vision of autonomous self-operating vehicles moves closer to reality, development of new technologies to avoid collisions with pedestrians and other accidents will become increasingly important. Here we describe several initiatives that will contribute to this goal.

More specifically, our work focuses on R&D of a vehicle-to-pedestrian communication system that cuts down on accidents involving pedestrians, cyclists, etc. that occur at blind intersections and other places with poor visibility through the exchange of positional data between pedestrians and approaching vehicles. The project involves two basic R&D components: a direct communication scheme permitting pedestrians to communicate with on-board systems using a dedicated pedestrian terminal, and use of a mobile phone type network over a widely deployed mobile phone network. With these two components, direct communication would provide early warnings while the mobile phone network would provide useful data for preventing traffic accidents on roadways with the full range of vehicles and other users—cars, trucks, pedestrians, cyclists, electric wheelchairs, etc.—based on a variety of data stored in the past and present.

2. R&D Issues and Fiscal 2014 Research Results

2.1 Direct Vehicle-to-Pedestrian Communication Technology

This project seeks to develop and deploy a vehicle-to-pedestrian communication system that averts traffic accidents through the exchange of positional information over dedicated terminals between pedestrians and approaching vehicles. The project has three basic components: (1) a technique for positioning pedestrians more accurately, (2) a pedestrian-vehicle communications protocol to be developed in parallel, and (3) proof-of-concept trials integrating the above two developments to assess and verify that the system actually mitigates collisions.

(1) High Positional Accuracy Technology

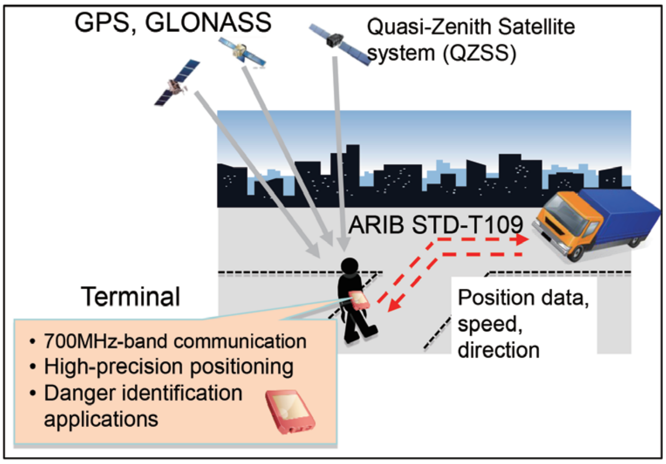
High positional accuracy of pedestrian terminals can be achieved by combining a number of techniques including compensation using L1-SAIF signals from quasi-zenith satellites, measures to correct for multipath errors, and pedestrian dead-reckoning that complements satellite positioning. Feasibility of the system was verified through experiments to assess the system's ability to identify danger and prevent accidents using "danger zone detection by maps", "detection of crossings based on the direction of movement and speed of pedestrians," and "relative positioning between vehicles and pedestrians". Positioning accuracy trials were conducted in fiscal 2014 using the quasi-zenith satellite to identify issues in environments with poor satellite reception, to evaluate traceability while moving, and to evaluate positioning performance in the height direction.

The results showed that the horizontal positioning error was 5-10 meters due to reflected waves between tall buildings and other urban obstructions, thus requiring measures to correct of multipath errors. We also found that vertical positioning by satellite had a large error, thus requiring an alternative approach. (Figure 1)

(2) Vehicle-to-Pedestrian Communication Protocol

To enhance the portability of the pedestrian terminal required a smaller more compact battery and a more energy-efficient 700MHz-band modem that is compatible with existing 700MHz-band vehicle-to-vehicle and vehicle-to-infrastructure communication systems. To meet these conditions, a new type of control was implemented that only operates 700MHz-band communications when required based on the state and

■ Figure 1: Overview of vehicle-to-pedestrian communication system



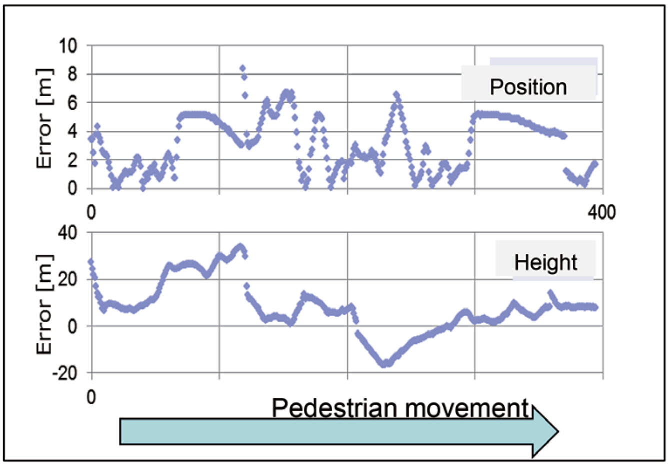
circumstances of pedestrians.

In fiscal 2014, we updated the message set of 700MHz-band communications in the pedestrian terminal to ensure compatibility with on-board terminal and to bring it into line with ITS FORUM RC-013 recommendations. We also implemented a new interface design for turning 700MHz-band communication on and off from outside the terminal, and verified that a Bluetooth (®)-based test model works properly. We confirmed that there is no interference between 700MHz-band communication and Bluetooth when both are operating simultaneously.

(3) Real-World Demonstration and Identification of Remaining Tasks

In fiscal 2014, a pedestrian terminal system was configured using three types of terminal equipment: dedicated terminals for positioning, smartphones, and 700MHz-band communication terminals. Field trials were then conducted on public roads in Yokosuka and Nagoya, and the system demonstrated good 700MHz-band compatibility between the pedestrian terminal and the on-board terminal even while using Bluetooth.

■ Figure 2: Positioning trial results (walking urban streets with quasi-zenith satellite)



■ Figure 3: Field trials: 700MHz-band terminals

2.2 Vehicle-to-Pedestrian Communication Technology Using a Mobile Phone Network

(1) Precision Vehicle-to-Pedestrian Detection System for Electric Wheelchairs

As an aging society with a falling birthrate, Japan can expect to see more and more electric wheelchairs and mobility scooters on the roads, and a growing number of traffic accidents. But if people could be warned of potential danger in advance, this could greatly reduce the number of accidents. This led us to propose a "motion detection system" that captures one's position using GPS and field intensity to determine the degree of proximity between electric wheelchairs and pedestrians and/or cyclists who are all in motion, and finally notifies both parties of looming danger.

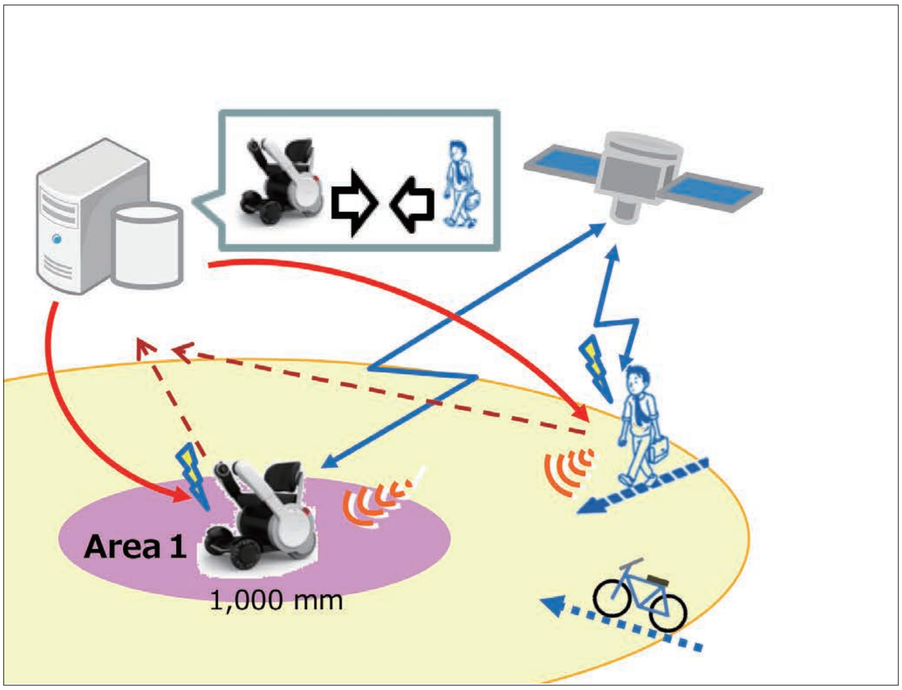
In fiscal 2014 we conducted basic experiments to measure relative position using Bluetooth Low Energy (BLE) field intensity and measure absolute position using GPS + quasi-zenith satellite (L1-SAIF (to reinforce the GPS signal)), and collect the data. We found that data revealing the direction from which an object is approaching a wheelchair (Area 1 in the figure 4) can be accurately positioned/estimated by GPS + quasi-zenith satellite, and a scheme for notifying the person in the wheelchair can be readily implemented by combining this data with BLE signal strength (or amount of variation). On the other hand, Area 1 in the figure 4 must be expanded to exploit the scheme as a danger detection system, and can only be realized by implementing a higher performance more effective combination by tuning the various measurement functions developed through this project.

(2) Information Collection/Distribution Using Web Technology over the Mobile Phone Network

Focusing on danger prediction and avoidance, this Web-based initiative will develop an efficient scheme for collection, analysis and distribution of next-generation probe data to achieve early implementation of a platform for collecting data from all kinds of vehicles and all kinds of roads. In fiscal 2014 we developed a system for collecting and analyzing speed and other driving data in the cloud using Web APIs that are now being standardized by the World Wide Web Consortium (W3C).

We evaluated the system over a one-month period by installing Web API-compatible smartphones on 100 taxis. As one can see in the lower portion of Figure 5, it took less than 5 seconds to upload the data (95% of total data) to the cloud even under very intense upload conditions of a one (1) second period,

Figure 4: Overview of the motion detection system



thus meeting our objective of providing danger predictions and warning messages at least 10 seconds before a potential accident might occur (upper portion of Figure 5).

Turning to pedestrian-related data, we are now investigating and verifying pedestrian-detection technologies based on images taken with an on-board camera and other related issues, while at the same time considering the level of privacy protection that is required by the legal system in developing setting functions.

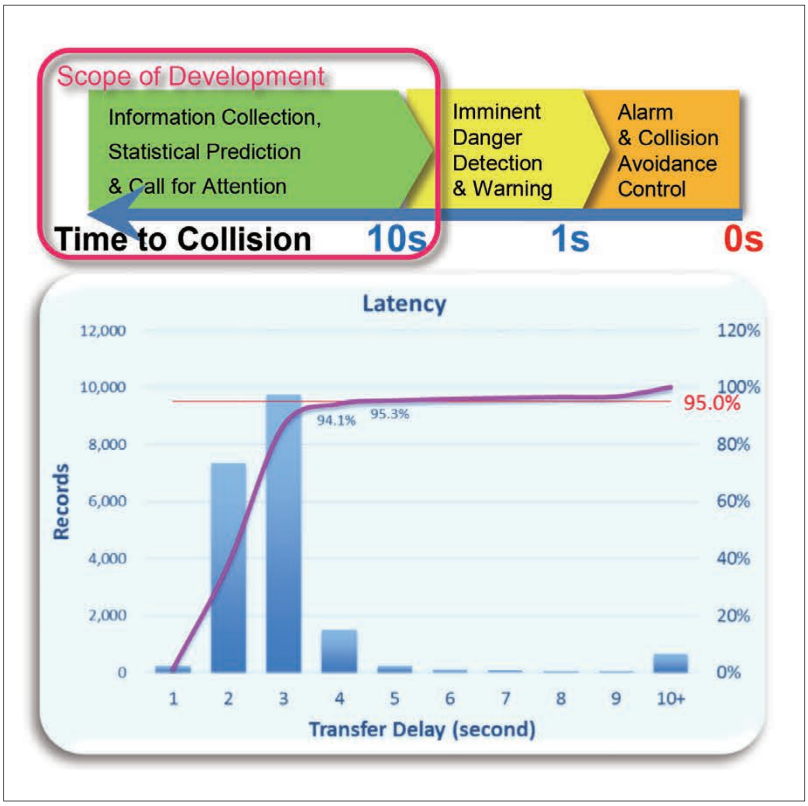
3. Conclusions

As outlined in this paper, we successfully achieved all of our first year objectives as planned. Let us next consider the direction of planning and research next year and beyond. In order to implement a direct communication approach, we will reduce positioning errors by mitigating multipath errors, and develop ways of detecting danger zones using maps and dangerous situations such as pedestrians crossing the street. We will also develop a communication protocol and conduct proof-of-concept trials on actual roads to verify radio interference by measuring 700MHz-band cellular throughput in the presence of a 700MHz-band communication terminal as a source of interference, then analyze how to miniaturize the built-in antenna to make the terminal more compact.

We also intend to build a vehicle-to-pedestrian detection system for electric wheelchairs by implementing a position calculation scheme and a real-time notification scheme. Finally, we will analyze whether the system provides sufficient lead time to warn drivers in advance so they can take evasive action if necessary.

In pursuing a viable scheme for collecting and distributing data using web technology over the mobile phone network, we have greatly expanded next-generation probe data and developed protective features in line with Privacy-by-Design principles based on the development and verification initiatives carried out in fiscal 2014.

Figure 5: Top: Scope of Web technology development
Bottom: Fiscal year 2014 results



Infrastructure Radar System as Next-Generation ITS Utilizing ICT

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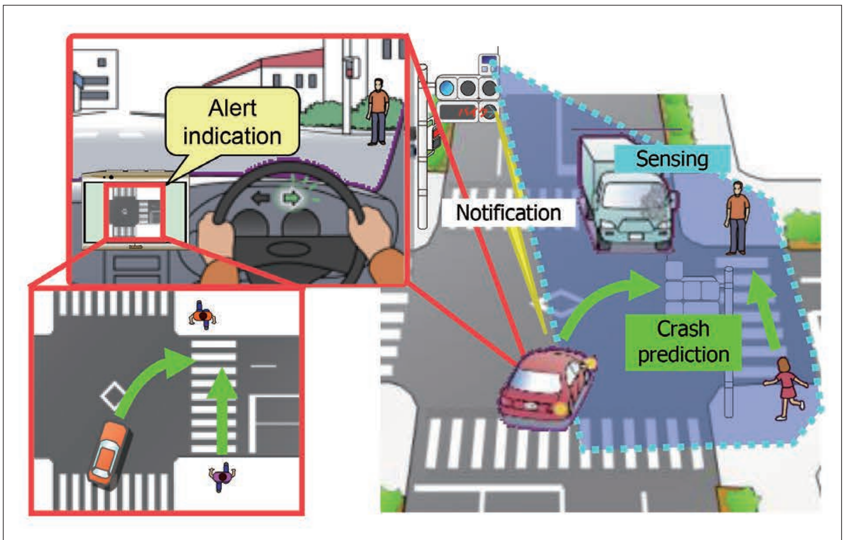
1. Overview of Research and Development

The goal of this R&D initiative is to develop and deploy a practical driving safety support system based on 79GHz-band high-resolution radar deployed as roadside sensors that is capable of detecting pedestrians, cyclists, motorized wheelchairs, and other smaller objects in or near roadways. This involves the development of infrastructure radar technology providing reliable detection, and robustness against interference and the environment; and development of a cooperative driving safety support system that contributes to safe driving conditions. The infrastructure radar technology requires a number of key capabilities: (1) “radar detection reliability enhancement” to improve the reliability of the radar for detecting pedestrians, (2) “radar mutual interference attenuation” permitting multiple radar systems (such as vehicle-mounted radar and infrastructure radar) to coexist and properly work in the same intersection, and (3) “environmental performance compensation” enabling the infrastructure radar to function properly even under adverse environmental conditions. The cooperative driving safety support system features a “cooperative driving safety system” that feeds data gathered by the infrastructure radar to vehicles in the vicinity. These initiatives are critically important for clarifying the extent that the system will function under adverse conditions; mainly, worsening detection performance and longer data processing time due to adverse weather.

Figure 1 shows an overview of the cooperative driving safety support system. The system consists of radar sensors mounted at approximately the same height as traffic signals that have a wide field of view (FOV) over the intersection. These sensors detect pedestrians, cyclists, and vehicles entering the intersection, then alert motorists to potential hazards in the intersection.

Yet we should note that the frequency allocation for 79GHz-band high-resolution radar is currently on the agenda for WRC-15 (to be held in November 2015), and preliminary studies are already underway in ITU-R meetings and other forums. Once the frequency allocation is resolved at WRC-15, we can anticipate that Radio Regulations (RRs) will be quickly revised, and new standards will be drafted by countries around the globe.

■ **Figure 1: Driving safety support system based on an infrastructure radar system for intersection surveillance**



2. Research and Development Progress to Date

Let us briefly summarize R&D progress that was achieved in 2014 relating to “radar detection reliability enhancement.”

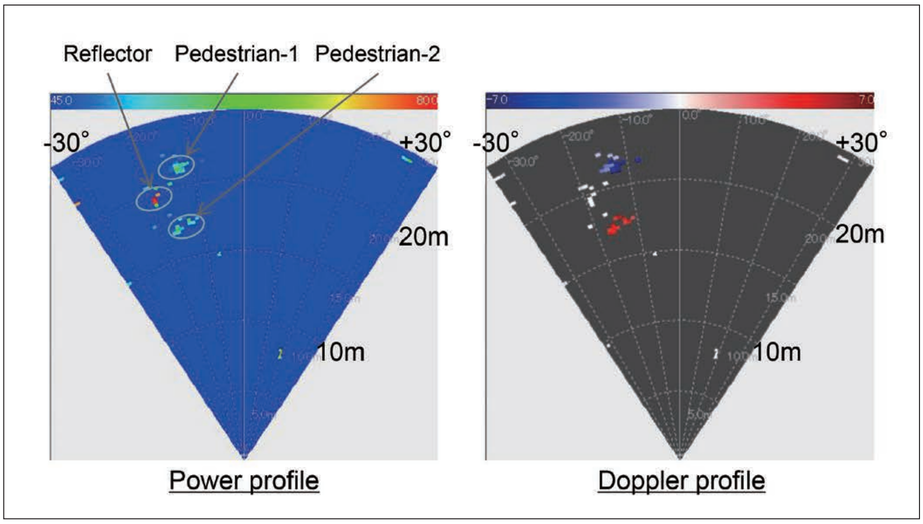
Before proof-of-concept trials can be carried out, a prototype 79GHz-band coded pulse radar system must be developed that can identify pedestrians from among mixed groupings of various objects, then extract features of pedestrian movement by Doppler frequency analysis. Experimental test stations must also be constructed.

First, preliminary evaluation trials were conducted in an indoor environment to assess the system’s ability to extract features from pedestrians. Operating specifications for the 79GHz-band radar used in the evaluation trials were field of view = about 60°, angle step 1°, Doppler resolution = less than 0.5 km/h. The detection objects included a standard reflector, R, as a stationary object about the size of a vehicle and two pedestrians, P1 and P2. As one can see in Figure 2, we could clearly discriminate the stationary object from the pedestrians based on the distance, azimuth, and the high-resolution Doppler spectrum.

Next, we conducted a basic radar mutual interference trial in which propagation conditions (conditions for the same carrier and the same pulse shape) were generated comparable to the arrival of strong interference waves in an indoor environment. Under these strong interference conditions, we qualitatively assessed the unique behavior of the interference wave by estimating the direction of arrival of the radar echo and the Doppler frequency.

In addition, we conducted propagation trials to quantitatively assess the detection performance. These trials were conducted

■ **Figure 2: Discriminating pedestrians from stationary objects by radar profiles (snapshots)**



■ **Figure 3: Measurement site with two roadside 79GHz-band radar installations at an intersection**

outdoors at the urban street simulation test course belonging to the Japan Automobile Research Institute (JARI) in March 2015. Measured data was collected for a range of different scenes while varying the height and depression angle of the radar, and changing the positional relation among various kinds of vehicles and pedestrians. The steering committee responsible for this R&D project came by to observe the trial on March 4, 2015.

We were able to measure power (echo intensity) and Doppler frequency radar profiles in the outdoor environment under conditions in which vehicles, guardrails, and other objects were in close proximity to the pedestrians. It was also found through the propagation experiments that we could analyze occlusion conditions caused by vehicles starting and stopping when pedestrians were detected by the roadside 79GHz-band radar.

Figure 3 shows the measurement environment. One can see that the site consists of an emulated intersection (2 lanes in one direction, 4 lanes in the other direction), and 2 roadside 79GHz-band radar installations at a height of 5 meters above the pavement. Figure 4 shows a typical screenshot of the measured data illustrating the results detected by the 79GHz-band radar units for pedestrians crossing the street and vehicles turning right and left superimposed onto a camera image of the intersection.

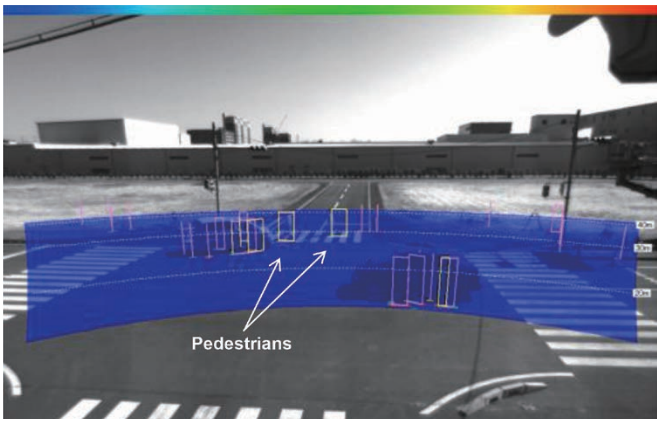
3. Conclusion and Future Initiatives

An experimental 79GHz-band pulse radar prototype was developed in 2014 that proved very effective for collecting data regarding pedestrian identification, occlusion modeling, etc. in an emulated street scene environment. While continuing efforts to devise a more accurate vehicle type discrimination algorithm and interference occurrence detection method, we are also working on more robust propagation data measurement and background clutter attenuation techniques that will work reliably even in heavy rain and snow conditions. We are also committed to the idea of field trials on public roads, since testing new technology under actual conditions is the best way to demonstrate practicality.

Acknowledgment

This work is part of the R&D initiative on "infrastructure radar systems" commissioned by the Ministry of Internal Affairs and Communications (MIC) as "Next-generation ITS utilizing ICT" for the Cross-ministerial Strategic Innovation Promotion Program (SIP).

■ **Figure 4: Detected results on the 79GHz-band radar units showing pedestrians crossing the street and vehicles turning right and left**



A Survey of Communication Technologies for Next-Generation ITS

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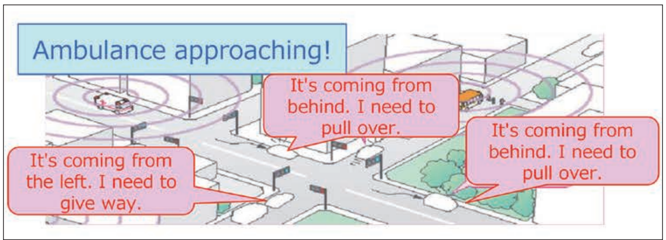
1. Introduction

The use of advanced ITS technology is expected to help Japan realize its aim of achieving the world's highest level of road safety. Now that Japan has switched over to terrestrial digital television, the 700 MHz band (755.5–764.5 MHz) is available for use by ITS technology. In this study, with the aim of hastening the commercialization of safe driving support systems using the 700 MHz band for purposes such as vehicle-to-vehicle communication, we identified and examined the issues that need to be studied in order to build roads and test courses that model actual working conditions based on comprehensive verification.

Furthermore, with the aim of developing a practical pedestrian communication system, we identified the requirements of pedestrian terminals, and considered ways in which they might be introduced.

Figure 1: Conceptual illustration of a safe driving system



2. About the study process

As for the investigation and verification of technical aspects, based on the results of various studies performed prior to this survey, we identified services that are expected to be implemented at an early stage, studied the security functions and message sets for these services, and compared them with foreign specifications to check their validity. After performing interconnection tests in a laboratory environment, we performed verification trials using real vehicles both on test courses and on public roads, and were able to confirm the feasibility of achieving the vehicle-to-vehicle communication needed to provide safe driving support.

The commercialization of services depends not only on the establishment of technical aspects, but also on the study and verification of operational management aspects. With regard to the latter, we performed a study of operational management methods including the registration, issue and storage of security keys, and an investigation of operational management methods for performing interconnection tests in practical applications, and we confirmed that the equipment functioned correctly.

3. Results of the study

(a) Extraction of services

To identify safe driving support services that are expected to be implemented at an early stage, we evaluated the achievements and issues of the ASV (Advanced Safety Vehicle) project (run by the Ministry of Land, Infrastructure, Transport and Tourism in partnership with various vehicle manufacturers), and services that have been studied by various organizations including the ITS Info-Communication Forum, ITS Japan, and ITS World Congress Tokyo. As a result, we extracted nine services requiring prompt attention: (1) crossing collision prevention, (2) right turn collision prevention, (3) left turn collision prevention, (4) provision of emergency vehicle information, (5) recognition of vehicle surroundings, (6) provision of quasi-public vehicle information, (7) using road management vehicles to report when roadworks are in progress, (8) using road management vehicles to provide information about congestion and dangerous locations, and (9) providing information about trams. Of these, items (1) through (4) are expected to be implemented in practice at an early stage. Compared with the services that are being studied in other countries, we confirmed that the directions of these services are broadly in agreement, although studies are being performed according to the traffic conditions in each country.

(b) Study of message sets

By studying whether or not the requirements of the services extracted in A are satisfied by the experimental inter-vehicle communication message guidelines drawn up by the ITS Info-Communication Forum (ITS FORUM RC-013), we confirmed that these guidelines are perfectly appropriate for the provision of message-based services. We also found that there were not major departures from foreign specifications, and that any differences that did exist could be made accommodated by minor modifications, thus confirming the suitability of the message set.

(c) Study of security features

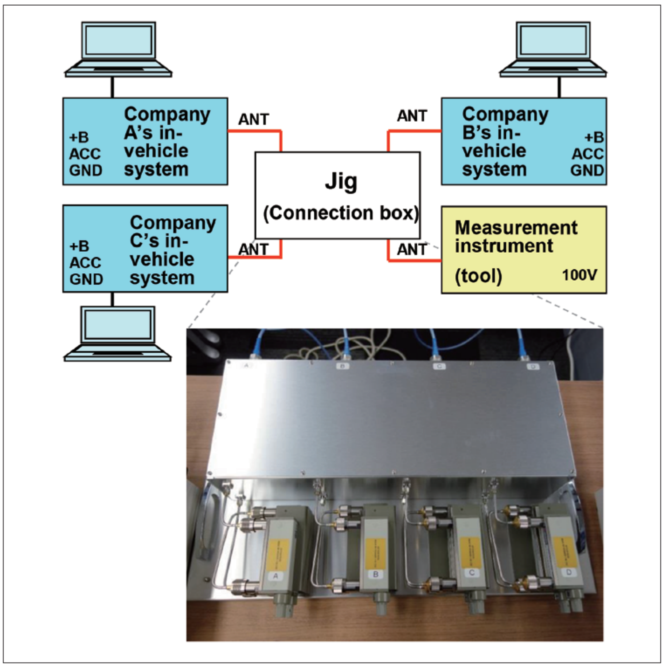
We investigated the five vehicle-mounted functions that perform secure communication — secure information storage, basic communication, authenticity checking, integrity checking, and confidentiality management — and obtained the expected results. Furthermore, in a simulated environment with many vehicles, we confirmed that it was possible for vehicles to transmit signals without difficulty while performing reception processing.

We also studied operation and management methods for the construction of a prototype system needed for managing the issue and registration of security keys. We tested this system under conditions close to actual operational workflow, and confirmed that the security requirements were all satisfied.

(d) Ensuring interoperability

To perform interoperability tests that will be needed for actual operations, we prepared documents such as "Interoperability confirmation testing" and "Operational management regulations", and we also created test jigs and measurement tools. We performed interoperability tests on prototype equipment from several companies based on the test procedure documents, and confirmed that it was possible to transmit vehicle information correctly between vehicle-mounted equipment that had been adapted for testing. After trying out the series of procedures for interoperability test applications, the scheduling and execution of tests, and the approval of equipment types based on the operational management regulations, we confirmed that it was possible to implement the expected tests and to take the steps necessary for the approval of equipment types.

Figure 2: Equipment configuration of interoperability tests



4. Comprehensive verification

Following the above studies and verifications, we used vehicles fitted with on-board equipment to perform comprehensive verifications on a test course simulating actual road conditions (simulated city roads at the Japan Automobile Research Institute), and on public roads (near the Yokosuka Research Park). As a result, we confirmed that vehicles were able to send messages to each other with the correct security functions in place. In the trials performed on the test course, we were able to recognize the security information of emergency vehicles for the provision of emergency vehicle information, which is one of the services that is expected to be put into practice early on, and we were also able to recognize fake emergency vehicles (i.e., ordinary vehicles that are pretending to be emergency vehicles by sending false messages.

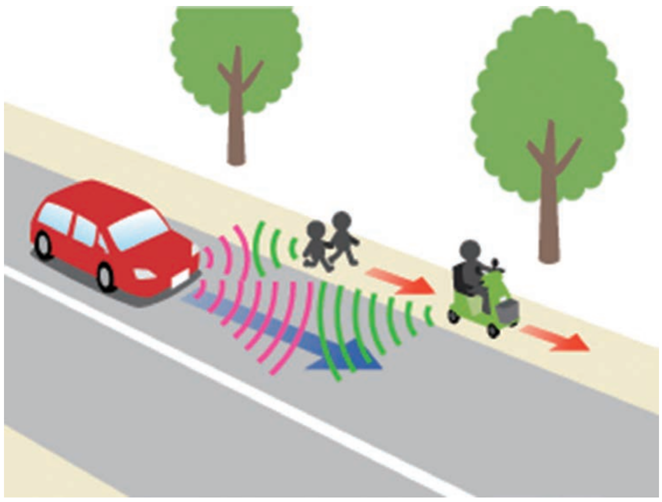
The on-board equipment verified in the comprehensive verification was used in the large-scale verification tests of the SIP (Strategic Innovation Promotion) program.

Figure 3: Comprehensive verification (test course) setup

5. Vehicle-to-pedestrian communication

Besides vehicle-to-vehicle communication, we also expect that vehicle-to-pedestrian communication systems will be introduced at an early stage to prevent pedestrian accidents (Figure 4). In this study, we examined terminals that are carried by pedestrians to communicate with vehicles. Through the selection of key targets by an accident analysis survey, a questionnaire survey of consumers, and an interview survey of manufacturers in various industries, we studied the functional requirements of pedestrian terminals and the acceptability of service pricing and the like. We also considered combinations of pedestrian terminals and existing products/services that are liable to be widely used.

Figure 4: Conceptual illustration of vehicle-to-pedestrian communication system



6. Conclusion

As described above, in this study we examined communication technologies that are fundamental to the practical implementation of next-generation ITS. In the future, it will be necessary to tackle the remaining issues with a view to facilitating the spread of this technology.

日本民間放送連盟

The JBA, the Largest Broadcaster Organization in Japan

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The Japan Commercial Broadcasters Association (JBA)

1. About JBA

Commercial broadcasting in Japan dates back to September 1951, with radio broadcasting by Chubu-Nippon Broadcasting (predecessor of CBC RADIO Co., Ltd.) of Nagoya and New Japan Broadcasting Company (predecessor of the Mainichi Broadcasting System, Inc.) of Osaka. Two years later in 1953, television broadcasting began and commercial broadcasters started to spring up all over the country.

The Japan Commercial Broadcasters Association (JBA) was established with the start of commercial broadcasting in July 1951 as a voluntary organization by 16 commercial radio companies that received preliminary licenses. In April 1952, it was approved to become a non-profit incorporated association. In April 2012, it shifted to a general incorporated association.

The members of JBA are broadcasters that provide essential radio and television services. At present, the membership consists of 206 commercial broadcasters (201 full members and 5 associate members). The membership does not include cable television or low-power FM radio stations.

The objectives of JBA include the enhancement of broadcasting ethics and the promotion, progress and development of public welfare through broadcasting. JBA works to identify and solve common issues while promoting friendship and cooperation among the members.

JBA gathers information about the issues that arise with the progress of technology and changes in the times and approaches the government with the collective opinions of all members.

The organization consists of the general assembly, the members' general council, the board of directors and 13 councils and committees. A secretariat consisting of 8 divisions handles the practical business affairs of each of these components. There are about 70 staff members in the secretariat.

2. Loudness Normalization of TV in Japan

During its 60-year history, one of the JBA's most important activities has been the standardization of broadcast technology. We have published many technical standards and reports, and have integrated diverse operating methods in order to achieve stable broadcasting. Local programs that are provided by regional commercial broadcasters supported by JBA technical standards contribute to Japanese broadcasting culture.

Loudness-based management of audio levels is one of the most important JBA standards, and all TV broadcasters in JBA introduced loudness normalization from 1st October 2012 based on a new JBA standard for expressing the average loudness of a TV program. As a public broadcaster, the Japan Broadcasting Corporation (NHK) has also been using the same management methods since 1st April 2013. These measures have greatly improved the TV viewing environment in Japan by bringing about a dramatic equalization of perceived loudness. They have also put an end to the so-called loudness war, and have completely eliminated complaints from viewers about loudness jumps between broadcast channels, between programs and intervening adverts. The introduction of loudness normalization is a great example of how an ITU Recommendation can contribute to the TV viewing environment at home.

The ITU developed recommendations for a loudness measurement algorithm (Rec. ITU-R BS.1770) and the requirements for loudness meters (Rec. ITU-R BS.1771) in 2006, and on the basis of these, it recommended loudness operating rules (Rec. ITU-R BS.1864) in March 2010. The operating standards of JBA adhere to this ITU recommendation.

JBA works in partnership with NHK and related organizations to promote standardization in Japan, and has made a large contribution to the proactive deployment and smooth introduction of public relations activities.

3. Efforts to combat global warming

JBA has been making various efforts to stop or reduce global warming. One such effort involves the production of short TV and radio programs (called "enlightenment spots") that are spontaneously aired by member broadcasters all over Japan. Since we are keen to preserve the natural environment and adapt to social situations where there is a need for energy-saving measures such as reduced power consumption, JBA produces programs containing eco-friendly tips that can be easily put into practice by viewers/listeners. These social contribution activities began in July 2008, and have now entered their eighth year. They are firmly established in Japanese broadcasting, and are highly rated as a unique kind of activity.

Enlightenment Spot (Example)

DISAster-information ANAlyzer (DISAANA) for SNS

— *Report on demonstration experiments in Miyazaki prefecture* —

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1. Introduction

At the National Institute of Information and Communications Technology (NICT), we are developing a disaster-resilient SNS information analysis system called DISAster-information ANAlyzer (DISAANA), which is publicly available on a trial basis at http://disaana.jp (Japanese only). Following the Great East Japan Earthquake, although useful disaster-related information was posted on Twitter and other social networking services (SNSs), people did not have the analysis and search means needed to use this information, so it was not easy for them to obtain the information they needed. At NICT, we have therefore been researching and developing systems that rapidly analyze disaster-related information posted to these SNSs in order to facilitate the provision of useful information not only to people who have been directly affected by the disaster but also to people involved in restoration and rescue efforts. One result of this work is DISAANA.

This article presents an overview of DISAANA, and reports on demonstration experiments performed in Miyazaki prefecture with local cooperation.

2. Overview of DISAANA

In its present experimental form, DISAANA is a question answering system that analyzes in real time the tweets that are posted on Twitter, and when a simple question is input, it instantly extracts and presents answer candidates from up to four days of tweets including the current date. It can be used not only on PCs, but also on smart phones and tablets.

Unlike conventional systems that provide information requested based on keyword searches and the like, DISAANA automatically extracts response candidates when a question is input.

There are a number of issues with searching in this sort of question answering format. One is that people use a wide variety of different expressions to say more or less the same thing, so searches can fail due to differences in how the questions are expressed. Another is that there are also a wide variety of expressions used to delimit the locations referred to in messages, and these may not be searched as intended.

DISAANA solves the first problem using a paraphrase database, created by automatically extracting paraphrases from hundreds of millions of web pages. Using approximately 300 million pieces of knowledge such as "*there is a shortage of X*, which can be reworded as *there is not enough X*," the search is extended when producing response candidates. The second problem can be solved by preparing a database of place names from information on approximately 3.4 million addresses and place names so that place names can be dealt with properly. Furthermore, each entry in the place name database is associated with latitude and longitude information that can be used to show the positions of candidate locations on a map at high speed. In general, most SNSs allow the attachment of GPS information showing the sender's location, but such features are hardly ever used due to privacy concerns. Therefore in DISAANA, instead of using GPS information, the message text is analyzed to identify the location and display it on a map.

Following the Great East Japan Earthquake, problems were caused by various false rumors that were spread around on SNSs. DISAANA deals with false rumors by not only retrieving response candidates but also retrieving response candidates from contradictory messages. Contradictory tweets are shown separately, simplifying the determination of whether the selected response candidate tweets are false rumors.

3. Demonstration experiments in Miyazaki Prefecture

With the cooperation of Miyazaki prefecture, we used DISAANA to perform demonstration experiments as described below.

Miyazaki prefecture is notorious for typhoons, and when typhoons approach the area, they are liable to cause flooding and landslides due to its geographical and natural characteristics. In recent years, a series of major landslides have been caused by typhoons and intense rainfall in 1997, 2004 and 2005, leaving deep scars in all parts of the prefecture. The possibility of a major earthquake occurring in the Nankai trough is also a cause for concern. Disaster prevention therefore has a high profile throughout the prefecture, and there are also efforts being made to cultivate disaster prevention experts.

When these disaster prevention experts and ordinary citizens with a high level of disaster awareness provide disaster-related information to SNSs, this information is analyzed by DISAANA, and is verified through disaster training as to whether or not it is useful to local government when making decisions about disaster measures.

An overview of the demonstration experiments is presented below.

(1) The test subjects (ordinary citizens and disaster prevention experts) are free to post messages on a bulletin board that mimics SNS. These messages describe the state of damage that is imagined to occur under the circumstances in which the test subjects are placed.
(2) DISAANA can provide disaster-related information through question responses by analyzing each submission in real time.

(3) The test subjects actually enter questions to check whether or not DISAANA can extract response candidates from their own writings.
(4) At the city hall's disaster response unit, the decisions to take steps such as issuing evacuation orders and launching rescue efforts are based not only on ordinary disaster information such as weather information and river water levels, but also on disaster-related information from citizens who are able to use DISAANA.

Demonstration experiments took place in the cities of Nobeoka (18th January 2015) and Miyazaki (7th February 2015) with a total of 115 test subjects and 15 local government officials who underwent training for five and a half hours. Over 4,400 messages were written, and DISAANA was able to answer over 1,760 questions. The test subjects were ordinary residents of Nobeoka and Miyazaki aged 18 and over (including those with disaster prevention qualifications). The test subjects accessed DISAANA through tablet terminals or notebook PCs provided by NICT to post messages on a bulletin board. The city hall officials at the disaster response unit all used notebook PCs. All the test subjects were gathered in a conference hall, and the test was started after the operating methods had been described for about two hours. The city hall officials in the disaster response unit were also given a similar description for about 2 hours, and performed the role of a disaster response unit in a separate room away from the test subjects. Figure 1 shows the disaster response unit in the demonstration experiments.

In this experiment, one person was designated as a controller, and was trained to convey the damage situation to the test subjects and disaster response unit members at various times during the test.

Figure 1: disaster response unit in the demonstration experiments

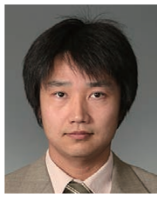
In other words, the rough situation was explained each time before the start of the experiment, but specific details such as the damage situation or changes in the weather (e.g., the duration of rainfall or the occurrence of tornadoes) were conveyed to the test subjects and the disaster response unit by the controller on an ad hoc basis. Under the given circumstances, the test subjects were relatively free to write messages to the bulletin board about the envisaged damage. Meanwhile, at the disaster response unit, DISAANA was used to check the disaster situation and coordinate the disaster response. In cases where there was insufficient information for a disaster response, the bulletin board could be used to obtain additional information.

After the test, questionnaires were filled in by the city hall officials in the disaster response unit, and by the test subjects playing the role of ordinary citizens. The test subjects described their expectations of DISAANA and suggested various improvements. The city hall officials commented that although the system was useful for disaster responses, there were valuable improvements that should be made from the viewpoint of putting disaster responses into practice. A number of these suggested improvements are reflected in the latest experimental release of DISAANA. Concerns were also raised about how to deal with the authenticity of information obtained in the tests.

4. Summary

This article has introduced DISAANA being developed by NICT and has discussed the demonstration experiments performed in Miyazaki prefecture. In the demonstration experiments, DISAANA was used for disaster response under conditions very close to reality, enabling us to clarify any issues, etc. It is also considered that DISAANA was able to fully demonstrate the possibility of providing information that is useful for decision-making in disaster response operations. In the future, we intend to improve the basic performance of DISAANA, expand its capabilities so that multiple organizations such as local governments and NPOs can respond to disasters efficiently by cooperating and collaborating with each other, and continue with the development of public tests.

An Overview of the Ofcom (UK) White Spaces Pilot, and the Involvement of the NICT



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1. Introduction

Around the world, studies are being conducted to develop technologies and systems to use the gaps between TV frequency bands ("white spaces") for secondary purposes without interfering with TV broadcasts. If new bandwidth can be made available, then it will not only be possible to accommodate increased traffic in wireless communication, but it will also be possible to use radio waves more flexibly by using different wireless systems according to the characteristics of radio wave propagation and the like.

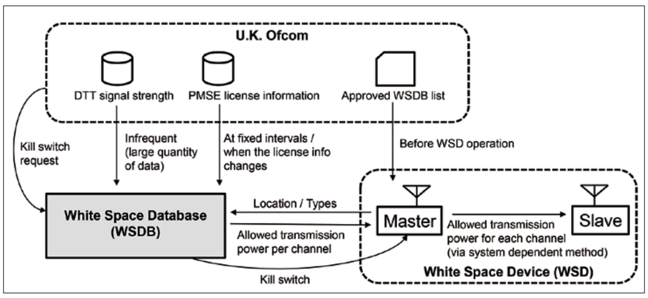
Under these circumstances, Ofcom (Office of Communications; the UK radio regulatory body) devised a project called the TV White Spaces Pilot to test and verify this framework with a view to establishing systems for the use of white space, and issued a call for participants in 2013[1]. Channels that are available for secondary use in white spaces are managed in a white space database (WSDB), and the channels that are available to a wireless communication device at a particular position are calculated based on information provided by Ofcom. A device selects one or more channels based on this information. In this pilot, Ofcom recruited external database providers and device operators to help verify these frameworks. Since the National Institute of Information and Communications Technology (NICT) has already worked to clarify technical issues by checking the performance of systems researched and developed for white space applications, we participated both as a database provider and as a device operator.

2. Overview of the UK white spaces pilot

In the UK, the 470–790 MHz frequency range is assigned to digital terrestrial television (DTT), with a bandwidth of 8 MHz per channel and a total capacity of 40 channels. In addition to the original TV broadcasts, this frequency band is now also used for so-called Program Making and Special Events (PMSE). PMSE refers to voice transmission systems that are used in program-making and other fields for purposes such as wireless microphone links and talkback from recording equipment. To use PMSE, it is necessary to apply for and purchase a license. In this pilot, it was required that there should be no interference of DTT or PMSE by white space systems.

The organization of the pilot and the flow of information are shown in Figure 1. Besides the organizer Ofcom, the pilot also includes database providers and device operators who perform testing.

Figure 1: Configuration and information flow of the pilot project



The database providers obtain DTT field strength information and PMSE channel assignment information from Ofcom. The DTT field strength information is obtained by recording the DTT field strength of each channel in every grid cell of a map divided into 100 m × 100 m squares. The quantity of information is very large (several tens of gigabytes), but has a low update frequency because it is not modified unless a TV station's broadcast specifications changes. On the other hand, the PMSE channel allocation information consists of the locations, channels, time slots and other information assigned to PMSE users by Ofcom. The database providers calculate the PMSE radio wave propagation by periodically accessing the PMSE information or receiving ad hoc updates from Ofcom, and calculate acceptable power levels for devices so that PMSE communication is unaffected.

The device operators select and connect to one database from the list of multiple Ofcom-qualified database providers when starting operations, request operational parameters including information such as the transmission power per channel allowed for the device, and start operating the device according to these operational parameters.

The device operators operate two categories of device: master and slave. A master device connects to the database to acquire operational parameters.

On the other hand, a slave device does not have a function for connecting directly to the database, but is instead assumed to be operated in the vicinity of a master device from which it can acquire operational parameters by a method particular to this system.

To handle situations where, for example, a device is found to be causing interference with DTT or PMSE services, the database providers are required to implement a function that forces the termination of radio emissions from corresponding devices when a particular region or device-specific ID is specified.

This "kill switch" function allows the operation of devices to be terminated by an instruction from Ofcom to a database provider, and by a change in the operational parameter information in the database.

3. Equipment developed by NICT

To participate in this project, NICT developed a database and devices for two types of system according to Ofcom's requirements as described below.

With regard to the database, we entered into a contract with Ofcom in December 2013, and were informed of their official approval in June 2014[2]. During this period, the NICT performed confirmation testing (offline tests) by itself based on procedures provided by Ofcom, after which an Ofcom appointee performed confirmation tests by directly querying the database via the Internet (online tests). As of December 2014, eight companies including NICT have had their databases qualified, and eight organizations including NICT, Google, Microsoft and Sony have been listed on the Ofcom web site.

One of the devices developed by NICT is a white-space-compatible LTE system that conforms to the 3GPP Release 8 standard, and another is a wireless LAN system that conforms to the IEEE 802.11af standard.

The former can perform TDD communication in a single channel, and can also use multiple channels to perform FDD mode communication with separate uplink and downlink. It can also use multiple consecutive channels simultaneously by switching between bandwidths of 5, 10 and 20 MHz in TDD and FDD mode respectively. The maximum transmission power is 1 W for a base station (eNB), and 100 mW for a user terminal (UE)[3]. The base station is connected via the Internet to an LTE control device called an Evolved Packet Core (EPC).

On the other hand, the latter has an operational bandwidth of 4.8 MHz and a maximum transmission output power of 1 W, and is able to use BPSK, QPSK, 16QAM and 64QAM modulation schemes.

Both devices pass Ofcom's Class 5 ACLR (adjacent channel leakage ratio) requirements.

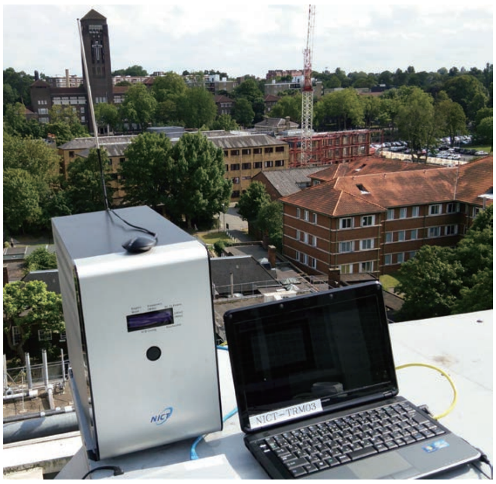
4. Test results

The devices we developed were tested in the city of London during July 2014 using two modes of communication — broadband mobile communication using an LTE system, and backhaul communication between fixed points using an IEEE 802.11af system.

The broadband mobile communication tests were performed with an LTE base station situated on the roof of a building in the Denmark Hill campus of King's College London, and transmission speed measurements were made while moving an LTE terminal around within the campus. From the results of these measurements, we found that the maximum UDP downlink transmission speed was 45.4 Mbps during FDD operation with two sets of 20 MHz bandwidth, and 19.5 Mbps during TDD operation with a 20 MHz bandwidth.

Next, in backhaul communication between fixed points, the IEEE 802.11af access point and terminal were situated in the Denmark Hill campus and Guy's campus of King's College London, respectively. The straight-line distance between the two campuses is 3.7 km, with a direct line of sight. For the antenna we used a three-element ring Yagi antenna with a gain of 7.4 dBi. During the tests, the transmitter power of the wireless device was set to 28 dBm based on transmission power value indicated by the database. According to the results of these measurements, it was possible to achieve a transmission speed of 2 Mbps with QPSK modulation (coding rate 1/2), but unlike the laboratory environment, there was a TV transmission tower situated 5 km from the Denmark Hill campus, and it was assumed that the full communication performance potential was not realized due to the effects of strong inputs received from the whole TV transmission band. Such issues are particularly important for white space communication equipment, and will need to be investigated fully in the development of future systems.

Figure 2: LTE base station installed on a roof in the university campus



5. Conclusion

This paper has presented an overview of a pilot project conducted by Ofcom in the UK to verify white space systems, and has introduced the results of tests in which NICT participated. The knowledge gained through this pilot has been fed back to Ofcom from the participating organizations, and a report based on this knowledge was published in December 2014. It is expected that the white space operating standards and technical standards drafted in Europe will also make progress in other parts of the world. It can also be used as a communication system for 5th generation mobile communications, or as a means for reinforcing propagation losses caused by defects in micrometer wave wireless systems and the like in communication between fixed points, and it is important to fully consider the value of these modes of use.

Acknowledgment

I would like to thank Dr. Oliver Holland of King's College London for his cooperation with the measurements and tests performed in London.

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= A Serial Introduction Part 4=
Winners of ITU-AJ Encouragement Awards

In May every year, the ITU Association of Japan (ITU-AJ) proudly presents ITU-AJ Encouragement Awards to people who have made outstanding contributions in the field of international standardization and have helped in the ongoing development of ICT.
These Awards are also an embodiment of our sincere desire to encourage further contributions from these individuals in the future.
If you happen to run into these winners at another meeting in the future, please say hello to them.
But first, as part of the introductory series of Award Winners, allow us to introduce some of those remarkable winners;

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ITU-T/SG13/Q15 – Data Aware Networking

Standardization of Data Aware Networking (DAN) for Future Networks

These days, we tend to use networks more for content retrieval than for communication between people. To respond to this trend, ITU-T Recommendation Y.3001 states that Future Networks should be able to deal efficiently with enormous amounts of data in distributed environments regardless of where the data is located. This design goal is embodied in a new form of network architecture, which ITU-T refers to as Data Aware Networking (DAN).

My first job at ITU-T was to edit the Y.FNDAN draft Recommendation initiated at SG13/Q15 in February 2012, which was the first step toward standardizing DAN for future networks. Nowadays, network architectures similar to DAN are called Information Centric Networking (ICN). However, when DAN was introduced, they went under various different names such as Content Oriented Networking (CON), Named Data Networking (NDN), or Content Centric Networking (CCN). These names were globally unified into ICN due to the advent of ICNRG (Information Centric Networking Research Group) under IRTF (Internet Research Task Force) in August 2012. This is the reason why DAN and ICN have different names despite fulfilling similar objectives. In November 2013, the draft Recommendation Y.FNDAN was approved, and became ITU-T Y.3033 – Framework of data aware networking for future networks. This is the world's first standard Recommendation describing the high-level requirements of network architectures for efficient content dissemination.

In February 2014, a draft Supplement to ITU-T Recommendation Y.3033 was initiated in the name of Y.supFNDAN, which includes DAN use-case scenarios. The purpose of the draft Supplement is to clarify the requirements in the design of DAN architecture from use-case scenarios. I have actively contributed to and edited the draft Supplement, which currently (May, 2015) contains six use-case scenarios: 1) content dissemination, 2) sensor networking, 3) vehicular networking, 4) networking in a disaster area, 5) advanced metering infrastructure in smart grids, and 6) proactive video caching. As the draft matures, we are able to derive the requirements of DAN architectures, and in May 2015, this resulted in the initiation of draft Recommendation Y.DAN-req-arch – "Requirements and Architecture of data aware networking", which specifies the requirements of DAN derived from the use-case scenarios in Y.supFNDAN, and defines a functional architecture to fulfill its requirements.

As an editor of the ITU-T DAN series including the framework (ITU-T Y.3033), use-case scenarios (Y.supFNDAN), and requirements & architecture (Y.DAN-req-arch), I hope that these Recommendations will guide the international standardization of network architectures like ICN in the future.

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Standardization of ID Management at ITU-T

Since 2001, I have been involved in work on ITU-T security standardization. I am currently engaged in standardization related to IdM as an Associate Rapporteur in ITU-T SG17 Q10.

There are various issues with ID management in its present form. For example, we are reaching the limits of authentication based on IDs and passwords. The standardization and popularization of other authentication methods are now being discussed. ID management schemes that work across multiple Internet services such as cloud services and social networks are also being studied and developed.

Protecting personal data and safeguarding privacy are becoming increasingly important. In the future, it may become completely impossible for businesses to operate unless they can reliably protect people's data and privacy.

It will also be necessary to consider how to allocate and manage the IDs of the tens of billions of sensors and other equipment that will be connected in cyberspace when the IoT (Internet of Things) era arrives. Ensuring compatibility between different ID management systems is another important issue. In ITU-T Q10/17, Recommendation X.1255 (Framework for discovery of identity management information) is being formulated as a framework for collaboration between ID management systems. Furthermore, we are studying further recommendations in order to realize cooperation between ID management systems in a more concrete fashion.

There are probably many different consortia and organizations around the world that are conducting research and development aimed at addressing the issues of IoT as well as other new issues that will arise. Through the activities of ITU-T Q10/17, I will carry on contributing to the standardization of ID management while cooperating with these related initiatives.

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Signal Processing for Wireless Communication, Millimeter-wave Communication

R&D and Standardization of Wireless Communications between Air and Ground

The first ITU standardization agenda that I became involved with was the discussion of provisions for the review and operation of frequency sharing conditions for high-altitude platform stations (HAPS) in WRC-07. In WRC-12, I was also involved with another HAPS agenda related to resolution 734 of WRC-07, which was to identify the frequency bands used for HAPS relay lines (Gateway links). A HAPS platform is assumed to use an aircraft such as an airship to locate the station at an altitude of 20 to 50 km, and I remember it seemed strange at the time that HAPS were treated as fixed stations rather than airborne mobile stations. However, my experiences there were helpful in subsequent technical studies and standardization activities for satellite and aircraft communications that I was involved with.

At present, I am engaged in the research and development of mobile communication systems using high-frequency bands such as the millimeter wave band, which can provide broadband communication, in order to meet the recent demand for Internet connectivity and high-speed data communication on board fast-moving vehicles such as aircraft and bullet trains.

As a possible means for realizing this, we have been developing a direct wireless communication system that uses the 40 GHz band to achieve transmission speeds of over 100 Mbps between the ground and the air.

The results of this research were reflected in the new report ITU-R M.2282: “Systems for public mobile communications with aircraft” in ITU-R SG5 WP5A.

We are also trying to deploy this technology on railways, and are promoting research and development to provide broadband access to high-speed trains. To reflect this achievement, we have proposed a new ITU-R report that summarizes the relevant technology in ITU-R SG5 WP5A, and are currently performing studies for the completion of the report.

I will also work on unmanned aircraft communication systems, which have recently become a hot topic, and I hope to contribute to the research, development and standardization of these systems.

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ITU-R SG 4 WP 4A, WP 4B

Using Satellite Orbits and Radio Frequencies Efficiently and Economically

It is a great honor to receive the ITU Association of Japan (ITU-AJ) Encouragement Award. If I may, I would like to take this opportunity to express my sincere gratitude to everyone who gave me their support and cooperation over the years.

I first started working with the International Telecommunication Union (ITU) in July 2010 at the ITU-R WP 4A/4B meetings. Since then, I have contributed to studies on the technical and regulatory aspects of satellite services using geostationary satellites, and have participated in major conferences including the World Radiocommunication Conference 2012 (WRC-12). My current mission is to achieve favorable results for the Japanese satellite community at the forthcoming WRC-15, where some important issues for satellite services are to be discussed (including a review of satellite network coordination and notification procedures, and the allocation of new frequencies to certain satellite services).

I believe these issues are very important because geostationary satellites are fundamental infrastructure in countries that lack an adequate terrestrial telecommunications infrastructure. As a matter of fact, the satellite market has experienced steady growth worldwide, with increasing demand both from countries and from companies, especially ones that currently lack their own satellites but are willing to launch them so they can benefit from the significant advantages of satellites in promptly and efficiently establishing nationwide service coverage. On the other hand, as stipulated in Article 44 of the ITU Constitution, radio frequencies and satellite orbits, including geostationary satellite orbits, are limited natural resources, so new entrants cannot easily secure desirable satellite orbits and radio-frequencies. Article 44 also stipulates that these limited natural resources must be used rationally, efficiently and economically. In this regard, however we should also note that it might be unreasonable to modify the regulations simply to facilitate the entry of new satellites, because such treatments may affect the reliability and profitability of existing satellite services, resulting in a negative impact on the satellite industry itself as well as its customers. One of the most difficult aspects of studies and discussions about satellite issues in ITU-R is striking an appropriate balance between these contrasting demands and finding mutually agreeable solutions among all the parties concerned.

I hope my work can contribute to achieving these goals.

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ITU-R WP5A, WP1B, IEEE DySPAN-sc 1900.4/4a

Cognitive Radio System (CRS) Standardization Activities

It's a great honor to receive such a prestigious award. I would like to start by acknowledging the research efforts of my colleagues whose work has made a real contribution to standardization activities, and the cooperation of the successive Japanese delegates on the ITU's cognitive ratio team with whom I have been working for almost eight years — Dr. Yoshino of Softbank Mobile, Mr. Kashiki of KDDI R&D Laboratories, and Mr. Shimbo of ATR.

At WRC-07, CRS was placed on the agenda for the following WRC[1], and a Question was also raised on this issue[2]. At ITU-R WP5A, work was therefore started on the preparation of a technical report on CRS. A group chaired by Dr. Yoshino was set up, and documents packed with highly accurate information were produced at each meeting. As discussion material for WRC-12, in November 2011, the parts of relatively old discussions that had been discussed at length were published in the first report[3], following which the chairman was replaced, the configuration of part 2 of the report was reviewed, and it was recommended that work was needed to make the report (which had grown to many pages) more orderly and concise. Three years later, the second report[4] was eventually published, marking the end of about eight years of activity.

Compared with other groups, there were more researchers participating in this group, and the ITU discussions led to the creation of joint studies and were also mentioned in the reports of overseas field trials. So I'm also very pleased with the feedback from these research activities. I hope that in the future I will be able to continue contributing by bringing the results of this sort of activity into discussions on standardization.

References

[1] WRC-12 Agenda Item 1.19:Software-Defined Radio (SDR) and Cognitive Radio Systems (CRS)
[2] Question ITU-R 241-2/5, "Cognitive radio systems in the mobile service"
[3] Report ITU-R M.2225, "Introduction to cognitive radio systems in the land mobile service," November 2011
[4] Report ITU-R M.2330, "Cognitive radio systems (CRSs) in the land mobile service," November 2014

47th Celebration for World Telecommunication and Information Society Day (WTISD)

The ITU Association of Japan

■ Photo 1: Group Photo

May 17 marks the anniversary of the signing of the first International Telegraph Convention. The Convention was signed in 1865, 150 years ago, and became the starting point of the International Telecommunication Union.

This year, the ITU Association of Japan (ITU-AJ) marked the occasion by holding the 47th Celebration for World Telecommunication and Information Society Day (WTISD) at the Keio Plaza Hotel in Tokyo, Japan, with over 270 participants from the Ministry of Internal Affairs and Communications (MIC), the Ministry of Foreign Affairs and the ICT industry. The ceremony featured a video message from the ITU Secretary-General, Mr. Houlin Zhao, celebrating our 47th WTISD event as well as the 150th anniversary of the ITU.

■ Photo 2: Video message from Mr. Houlin Zhao

At each year's Celebration, ITU-AJ presents awards to recognize those who have furthered the aims of WTISD by raising awareness of how information and communication technologies (ICT) can contribute to international standardization and cooperation between societies and economies with regard to sustainable development goals, and can help bridge the digital divide. This is a long-established award ceremony that was first held 43 years ago.

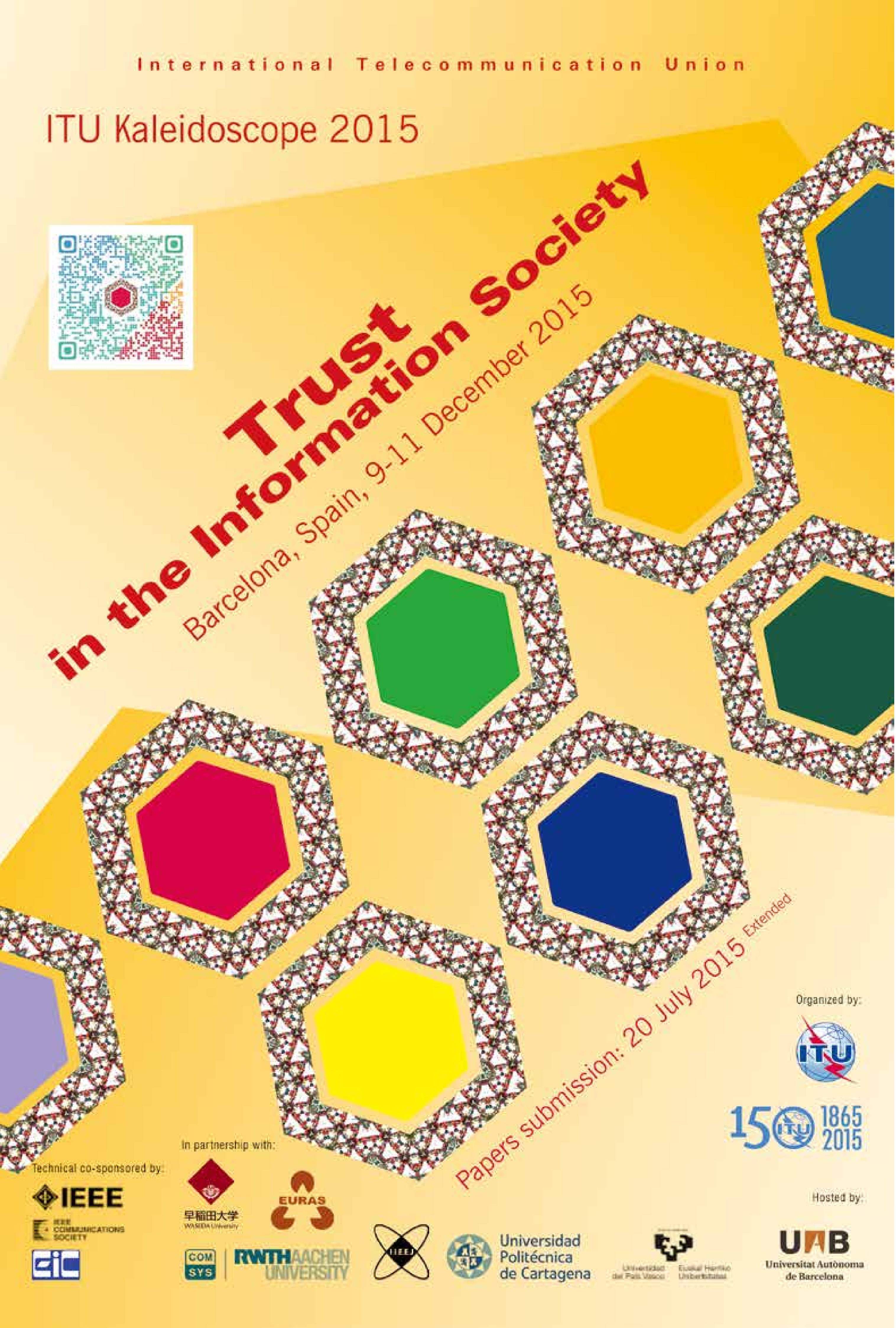
The highest honor — the MIC Minister's Award — was presented to Toshio Obi, Professor of GSAPS and Director of the Institute of e-Government at Waseda University.

Other ITU-AJ Awards, in the form of trophies, were also presented to prominent figures in the fields of standardization and international cooperation, as listed below.

Awards for accomplishment in the field of ICT (international standardization) were presented to seven winners, while awards for accomplishment in the field of international cooperation were given to eight winners. Encouragement awards were presented to twelve winners in the field of ICT and seven in the field of international cooperation, in expectation of their on-going contributions in their respective fields.

The list of award winners is as follows:

MIC Minister's Award
Toshio Obi, GSAPS/ WASEDA UNIVERSITY
ITU-AJ Award: Accomplishment in the Field of ICT
Hiroshi Ota, ITU Shigeyuki Sakazawa, KDDI R&D LABS Kazuyuki Shiraki, NTT Masaru Takechi, NHK Kenji Furukawa, NTT DOCOMO Akira Matsunaga, KDDI Makoto Murakami, NTT
ITU-AJ Award: Accomplishment in the Field of International Cooperation
Asia Mobile Backhaul Improvement Project: Contribution to Environment of Broadband Communication in APAC Region, NEC Yosuke Uchiyama, KDDI/KDDI FOUNDATION Masayoshi Kuwahara, NHK (retired) Jiro Kokan, NTT (retired) Tadayoshi Kotoge, BHN ASSOCIATION Toshikazu Sakano, ATR Atsushi Takahara, NTT Hiroshi Toda, ITEA Kiyoshi Mushu, NTT (retired)
Encouragement Award: Field of ICT
Kota Asaka, NTT Koji Isshiki, NTT-AT Hiromasa Umeda, NTT DOCOMO Masashi Eto, NICT Makoto Kadowaki, NEC MAGNUS Kohei Kambara, NHK Kiyoshi Tanaka, NTT Sei Naito, KDDI R&D LABS Satoshi Nagata, NTT DOCOMO Nobuhiko Naka, NTT DOCOMO Kazutomo Hasegawa, FUJITSU Yusuke Fukui, KDDI
Encouragement Award: Field of International Cooperation
Kazuhiko Akatsu, NTT EAST Minako Akiba, BHN ASSOCIATION Yoshinori Kawana, NHK Susumu Tanaka, NEC Digital Broadcasting Experts Group, ARIB Shinichi Nobutsune, KDDI FOUNDATION Hiroshi Fujita, NHK



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