5 Data Connection and Use to Achieve Society 5.0

Building and Designing a Geographic Architecture (Overview)

Raita Hiraoka, Hiroaki Kimura (Cabinet Office)

1 Background

In the society that we should aim for as Society 5.0, new business models will be born through the advanced fusion of cyberspace and physical space, and innovations born from the utilization of big data and AI will create new value in various fields, leading to a paradigm shift in the economic and social system. In order to realize such innovations, it is important to coordinate data not only by field, as has been the case in the past, but also across fields.

In SIP "Big-data and AI-enabled Cyberspace Technologies," in 2019 we began the development of "cross-field" and "field-by-field" data coordination infrastructures, as well as the construction and testing of an architecture based on a framework for deepening the views and understanding among all stakeholders, ensuring interoperability among these infrastructures, and developing technologies and standardization that enable mutual coordination and cooperation (hereinafter referred to as the Society 5.0 Reference Architecture; Fig.1). This initiative is being expanded to smart cities, geographic information-related fields (automated driving, agriculture, disaster prevention, and infrastructure), and personal-related fields. In the SIP-adus (Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services), we have begun constructing an architecture for geographic data.[(1)]

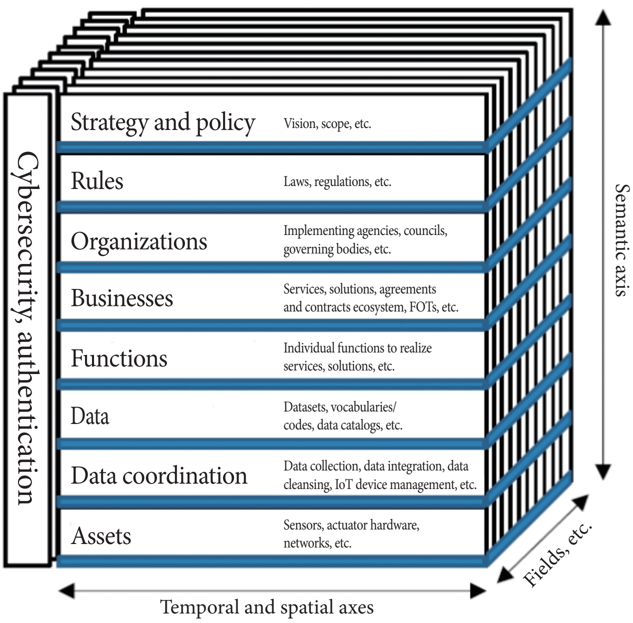


Fig.1: Society 5.0 Reference Architecture

2 Activities in SIP-adus

In the SIP-adus, we put together an architecture of automated driving fields related to geographic data (hereinafter referred to as the Automated Driving Architecture) (Fig.2) based on the Society 5.0 Reference Architecture.

Since the first phase of SIP-adus , we have been working on the generation and distribution of high precision 3D maps and dynamic road traffic environment data necessary for automated driving, but cost reduction is a major issue for their widespread use. On the other hand, it is highly possible to reduce costs by utilizing 3D point group data and vehicle probe data, which are

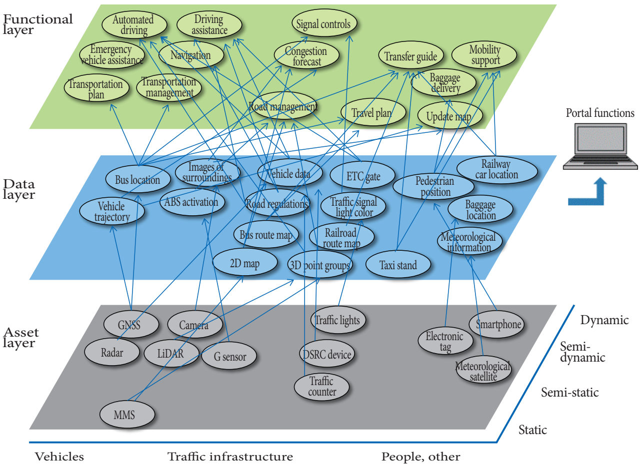


Fig.2: Automated Driving Architecture

the data layer for generating such road traffic environment data, in other fields as well.

We believe that the problem is an imbalance between data users who do not know that data exists and data providers who do not know the needs for their data. To address this, we decided to work on the construction of a portal site with data catalog and data search functions.

In addition, since it is important to create examples of data utilization using this portal site, we held an "App Contest to Solve Issues Related to Transportation in Kyoto, a Tourist City" to broaden the scope of data utilization efforts and to gather opinions on how to improve the usability of the portal site.

In addition, we promoted the broader utilization of geographic data in collaboration with other SIP-adus projects, such as the use of probe vehicle data to improve logistics efficiency and support road management operations.

In 2020, we surveyed and analyzed examples of mobility-related data utilization in Japan and abroad, and based on the results of interviews with data providers, service providers, data collectors, and academic experts, we held discussions at a study group consisting of experts and compiled draft guidelines for data handling in the mobility field as well as a proposal for public-private data coordination.

2.1. Construction of the Portal for Road Traffic Environment Data "MD communet®"

In constructing the road traffic environment data portal, while assuming services in the functional layer based on the automated driving architecture, we aimed to aggregate, visualize, and catalog data layers such as road traffic environment data to serve as a trigger for matching data providers and data users, thereby enabling one-stop browsing. (Fig.3) In addition, the system has an advanced data search function that uses not only keywords but also area and purpose of use as keys, searches for similar data using machine learning, a suggestion function, and other functions that promote matching of needs and seeds.

This portal supports the promotion of data distribution and the creation of new services by enabling diverse users to utilize road traffic environment data for various services through an open portal web site called "MD communet" (https://info.adus-arch.com/) (Fig.4), the portal website was established and made available in October 2020. After that, efforts were made to expand the number of users, chiefly through data providers, and in April 2021, the website was made available to the general public with 11 participating companies and organizations.

Fig.3: MD communet, a data matching website

To promote the use of the portal site, we have improved the user interface by incorporating the opinions of "MD communet" users, and have otherwise worked to make it a portal site that is easier to understand. We have held various events to enliven matching activities, including an "Idea Creation Event" in November 2021, a "Business Matching Event (MD com Match)" in March 2022, and an "Idea Creation Workshop" in March 2022, and have worked to create many examples of portal utilization. As of the end of July 2022, 43 companies and organizations had registered to participate, and 7,316 catalog data items had been posted. [See Section 5 1) for more details]

When we look at trends overseas, we see that the EU made it mandatory for member states to establish National Access Points (NAPs) in 2017 in order to encourage the collection and use of mobility data, and stipulated that data on transportation and travel must be provided through NAPs by the end of 2030. In Germany, the Federal Ministry for Digital and Transport started operating a mobility data platform called Mobilithek in July 2022, which will serve as an NAP. Like "MD communet," it is a portal site with data cataloging and search functions.

As described above, efforts to promote the utilization of transportation data are becoming more active overseas, and it is necessary to develop "MD communet" in Japan. Even after the completion of SIP, NTT DATA will operate "MD communet," and plans to improve usability, enhance services and content, increase awareness, and create usage examples.

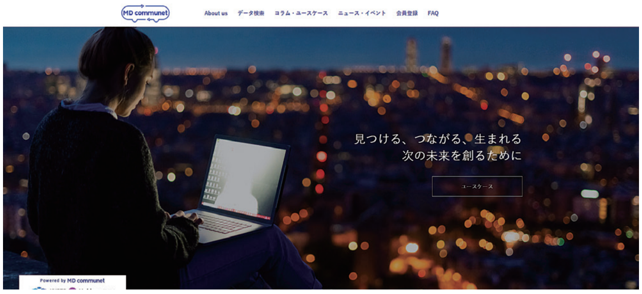


Fig.4: MD communet website

2.2. Holding of App Contests

In order to create use cases that help to solve transportation-related issues by utilizing road traffic environment data and mobility-related data, we held a contest (the first "App Contest to Solve Tourism and Transportation Issues," nicknamed the "KYOTO Raku Mobi Contest") in October 2020 to solicit apps and ideas for solving tourism and transportation-related issues faced by Kyoto, a world-class tourist city. The contest was conducted with the cooperation of the Kyoto City Transportation Bureau and other operators, and included data on stations, stops, routes, timetables, and fares for public transportation systems such as buses and railroads; data on temporary luggage storage and delivery services and stores for logistics; congestion forecasts for sightseeing facilities; information on sightseeing spots; center guide service API, and congestion statistics data. Although there were excellent applications (Fig.5) and ideas in the first KYOTO Raku Mobi Contest, they were not put into practical use due to the fact that the data could not be distributed continuously after the contest. However, the contest did generate momentum to open up bus information, especially in the Kyoto City Transportation Bureau, and expectations for the second contest were raised. Municipal and private bus companies in Kyoto City will create bus information in GTFS-JP format and register it in "MD communet." Information such as probe vehicle data from logistics companies and tire manufacturers will also be provided on "MD communet." The second "App Contest to Solve Tourism and Transportation Issues" is scheduled to be held in December 2022. Through this contest, we aim to raise awareness of the road traffic environment data portal and obtain feedback from data users who entered the contest, which we will use to make improvements to the portal. [See Section 5 2) for more details]

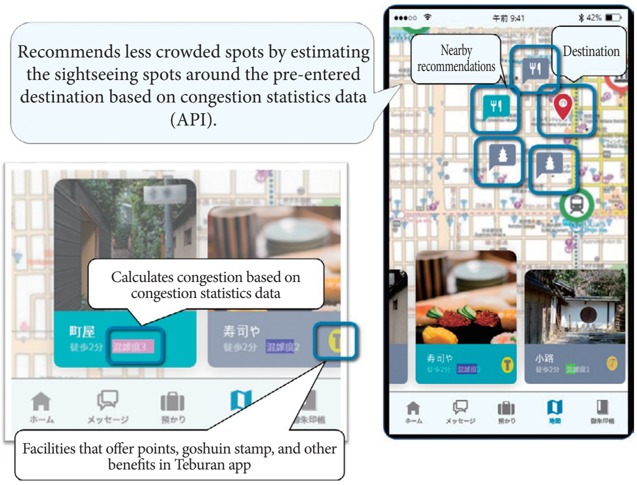


Fig.5: KYOTO Raku Mobi Contest
The SIP-adus Award Winning Apps

2.3. Development of Support Systems for Local Automated Driving Services

We clarified common issues in socially implementing automated driving services in rural areas, and developed a common reservation and operation management system called "Mobisuke" (location management of vehicle positions, safety monitoring using camera images inside and outside the vehicle, reservation management, boarding/exiting information management, etc.) with an interface that is easy to use for everyone, including the elderly. In developing this system, we conducted field operational tests (FOTs) in collaboration with the initiatives of Higashiomi City, Shiga Prefecture; Miyama City, Fukuoka Prefecture; and Takahata Town, Yamagata Prefecture, in addition to Kamikoani Village, Akita Prefecture, and Iinan Town, Shimane Prefecture, which are promoting social implementation of automated driving services under the SIP-adus, to improve functions based on feedback from service providers and users.

In the future, while providing "Mobisuke" as an inexpensive and convenient system, we aim to commercialize support services, including the system, in the interests of strengthening interregional cooperation and with a view to utilizing the communication function of the road traffic environment data portal.

2.4. Improving Logistics Efficiency Using Probe Vehicle Data

With the aim of improving cargo wait times in transportation operations, improving work times for checking daily inspection items based on vehicle and probe data, improving operation schedules and control by real-time understanding of load weight and tire information, and making other improvements demanded of the logistics industry, we clarified an architecture for future data coordination/utilization in which data obtained from logistics trucks is utilized to improve logistics efficiency.

In order to improve the wait times for cargo, we obtained and analyzed the data from the carriers' actual vehicles. Both carriers and consignor companies shared their awareness of the circumstances behind the occurrence of wait times for cargo. We analyzed the causes of wait times and considered measures for improvement. (Fig.6)

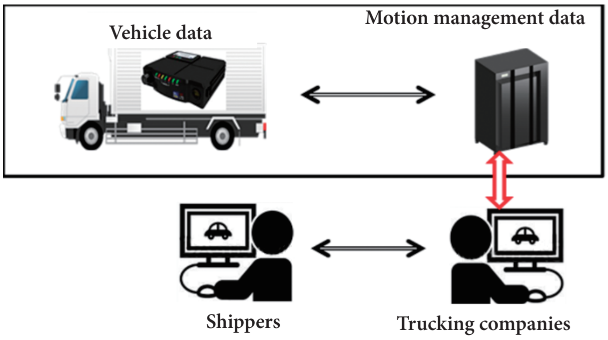


Fig.6: Schematic of vehicle and motion management data collection and sharing

To improve work times for checking daily inspection items, truck manufacturers' own vehicles were used to check the status of trucks for daily inspection items remotely by identifying event data that contributes to the checking of daily inspection items from vehicle and probe data. In addition, we proposed standardizations of data formats for cooperative areas of vehicle information such as probe data, and provided information (data catalogs) to "MD communet" to promote further utilization of data in the future. [See Section 5 3) for more details]

2.5. Utilization of Probe Vehicle Data in Road Management

As examples of the use of probe data collected from vehicles, we studied the detection of slippery road surface conditions caused by bad weather conditions such as rain, the detection of flooding on roads and the provision of alert information, as well as the use of the information for road maintenance management by estimating the amount of rutting from the amount of water film detected on the road surface.

In cooperation with OEMs and tire manufacturers, we collected information on ABS operation, vehicle skid control operation, tire spin control operation, wiper operation status, tire grip level information, and other data from vehicles in motion. The accuracy of generated detection information based on statistical processing was verified through FOTs on actual roads. [See Section 5 4) for more details]

[References]

(1) The Second Phase of SIP-Automated Driving for Universal Services Research and Development Plan, https://www8.cao.go.jp/cstp/english/04_autodrive_rdplan.pdf, (accessed 2022.06.30)

[Contacts]

Secretariat of Science, Technology and Innovation Policy Cabinet Office, 1-6-1 Nagata-cho, Chiyoda-ku, Tokyo 100-8914, 03-6257-1334 Contact: Raita Hiraoka, Hiroaki Kimura

1) Design of Geographical Data Architecture — Building and Promoting a Traffic Environment Data Portal Site

Naoki Iso (NTT DATA Corporation)

(Abstract) The data collected for automated driving, such as high precision map data, road traffic data, and vehicle probes, are expected to be used as road traffic environment data in various other industries as well as the automotive industry. In order to realize a mechanism to allow this, we constructed and released "MD communet®," a portal site for road traffic environment data that aggregates data in the mobility field and links it with other fields. Aiming for the continued operation of MD communet, we have also promoted activities to spread the service, such as acquiring more member companies, increasing awareness through various promotion, and creating offline/online matching opportunities. In addition, we have developed service examples that effectively use road traffic environment data, which is the key to social implementation of this system, in combination with information from other fields, and have studied the support functions necessary for service development.

Keywords: Road traffic environment data, Society 5.0, data coordination, business matching, data utilization service creation

1 Construction and release of "MD communet," a portal for road traffic environment data

1.1. Value provided by the portal site

The goal of this program is to contribute to solving social issues, such as reducing traffic accidents, reducing traffic congestion, ensuring mobility for road users with limited mobility, and improving the shortage of drivers and reducing costs for logistics and mobility services, which will be achieved through the practical application and expansion of automated driving, ultimately creating a society in which all people enjoy high quality of life. This reflects our belief that contributing to the practical application of automated driving is required to realize a safe and secure society, solve social issues, and create new business value for these purposes.

To contribute to achieving the goals of this program, we have created "MD communet," a portal site for road traffic environment data, as a place where people, information, and data can gather and create various ideas and services. As shown in Fig.1, this portal site aims to promote the utilization of data and the creation of new businesses through the portal site by aggregating a wide variety of road traffic environment data in the mobility field from around the world, and by creating various opportunities for users to communicate with each other.

For this reason, after equipping the portal site with the basic functions required from a catalog search site, we advanced development with a focus on the implementation of three major functions: the promotion of business matching, the expansion of data, and UI/UX improvements based on user feedback.

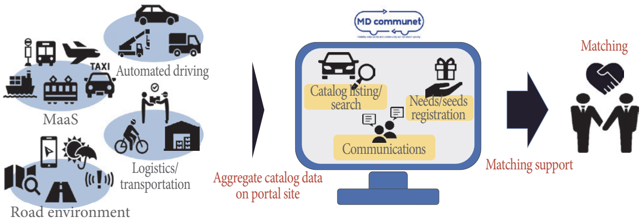


Fig.1: Image of business creation through the portal site

1.2. Business matching on the portal site

As mentioned above, the development of this portal site's functions focused on proactive search and communication functions to facilitate business matching.

Fig.2 shows an overview of the functions provided by portal sites. The main functions provided by the portal site are shown below.

(1) Data catalog registration and search functions

This function allows users to register catalogs and publish them for other users, and provides various search methods so that users can easily find the data they are looking for.

Specifically, keyword search, conditional search, and area search functions have been implemented on the top screen, and re-search and faceted filter search functions have been implemented on the search results screen.

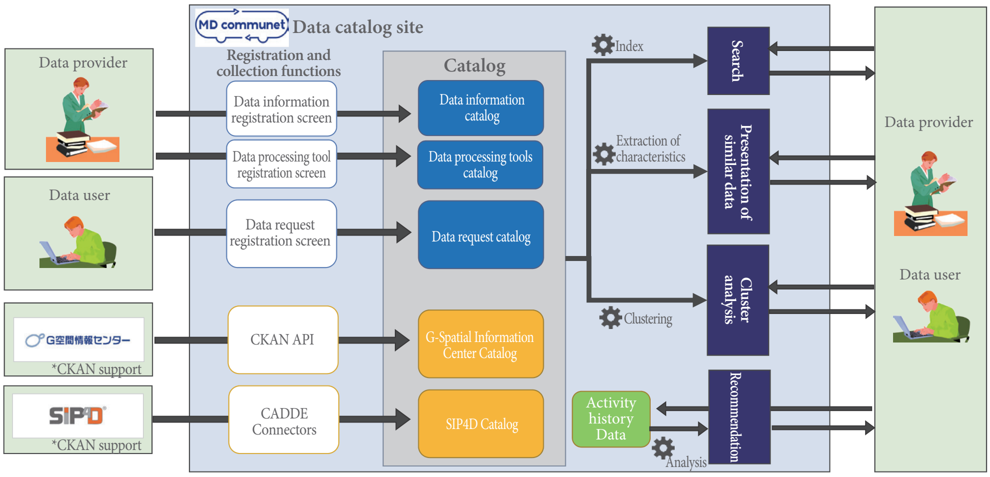


Fig.2: Overall portal site functions

(2) Communication functions

This function is designed to promote the discovery of new data usage methods and direct business matching by directly connecting data providers and users.

Specifically, we implemented a function to evaluate posted data and a message function to enable direct communication among users.

(3) Recommendation function

This function recommends catalog data from the system in order to provide users with unexpected discoveries.

Specifically, we implemented a function that provides recommendations based on user access information, and a similar data function and clustering function that uses machine learning.

(4) Associative word support function for search terms

This function presents the user with related keywords that are associated with the search term.

Specifically, we implemented a function that enables the retrieval of related keywords from an external repository (DBpedia) for each search term. This means that related term information is not stored internally and the retrieval destination can be set flexibly.

(5) Company profile

A function that allows each company to post their achievements and activities, providing users with information about the company itself and creating expectations for matching from perspectives other than those of the actual catalogs.

Specifically, we implemented a function that allows companies to introduce their initiatives and post text and data such as editorials and use cases on the website for dissemination and promotion.

(6) Linked Data creation

A function that enables the operator to obtain sources for information to be disseminated to member companies based on user activity logs and data relevance.

Specifically, we implemented a function that enables notification of recommendation information to member companies by converting the metadata for registered catalog data and logged-in user activity logs into Linked Data, which can then be searched by management.

1.3. Portal site data expansion

In order to further promote business matching through the portal site, it is essential to expand the available data. As a response to this requirement, data expansion was implemented in terms of both the volume and types of registered data.

In terms of data volume, we also implemented linkage with existing data platforms, such as the G-Spatial Information Center and SIP4D. Furthermore, by implementing the CADDE connector in the SIP inter-program data coordination, as shown in Fig.3, it is possible to efficiently obtain data catalogs from other programs.

In terms of data types, in addition to data information and data requests, data processing tools can also be posted, thereby expanding the data while increasing the number of stakeholders involved in the creation of new services.

As data expansion progresses and the probability of matching increases when highly related data and logs are linked, it is expected that strengthening both will create a synergy in the promotion of business matching.

1.4. Portal site UI/UX improvement

After the opening of the portal site to the public, opportunities for business matching are expected to increase due to the additional member companies and the accompanying expansion of the data catalog, and the role of the portal site as a place where more data, people, and information can be gathered is expected to become more important. In addition, for the purpose of attracting more member companies, UI/UX improvement has been continuously implemented in conjunction with various

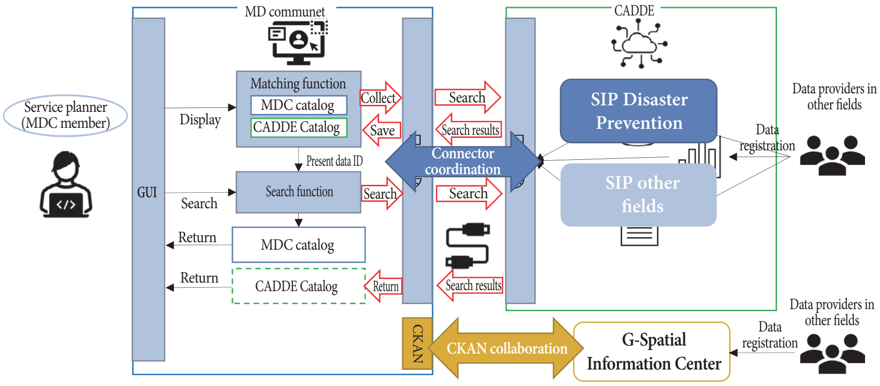


Fig.3: Example of additional development for enhanced functionality

Concept for periodic metadata harvesting function

promotion activities, such as studying the optimization of the system lines to link from the promotional activities websites to the portal site, as shown in Fig.4.

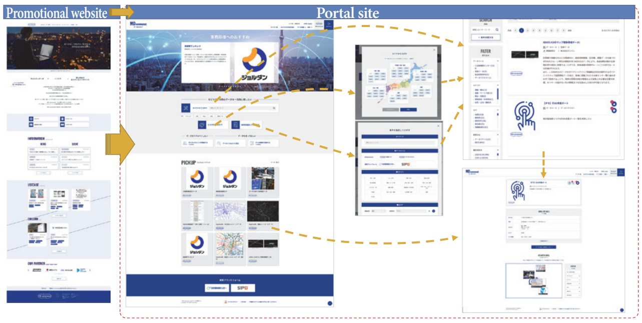


Fig.4: Optimization of lines from promotional activities websites

2 Undertakings to promote MD communet

2.1. Outline of activities

In order to continue to operate MD communet, it is important to create new services and values by gaining wide recognition, making allies, and promoting data utilization through matching. In the process of creating allies, it is necessary not only to find partners who agree with MD communet's initiatives and can create together, but also to build an operation and promotion system that will enable users to conduct transactions smoothly. In the promotion of data utilization, it is necessary not only to collect a wide range of road traffic environment data, but also to create encounters with unknown data by publishing characteristic data from both the public and private sectors, leading to the creation of new services and values. Therefore, in FY2019 and FY2020, we focused on building a network, expanding the data to be posted, and increasing awareness.

2.2. Creating allies for MD communet

For the continuous operation of the portal site, "matching" including personal relationships with each party is the most important prerequisite, and we specifically aimed to create allies for this project. First, in order to identify the appealing points of MD communet, which are vital in the creation of new allies, we organized the worldview and values to be achieved (as shown in Fig.5). This was based on our objectives and the project concept. We also defined the ecosystem that we wish to form through this project.

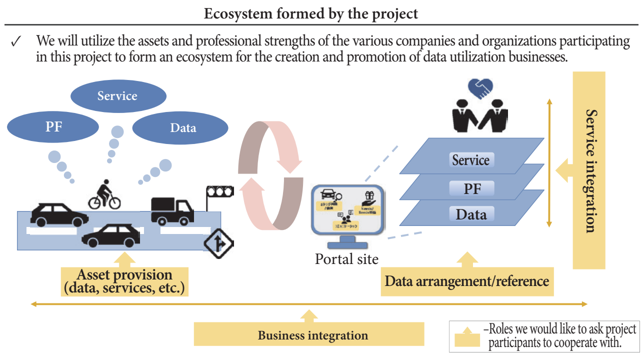


Fig.5: Ecosystem formed by the project

Next, we surveyed and organized the stakeholders necessary for the realization of the ecosystem in the public sector and in the private. First, we visualized the flow of vehicles and people on the road, assumed use cases in which road traffic environment data would be used, and investigated the flow of data collection and distribution. As shown in Fig.6, we classified stakeholders into the public and private sectors. For the public sector, we assumed public offices and public interest incorporated associations that own or have jurisdiction over road traffic environment data. For the private sector, we assumed businesses and service providers that offer telematics services. The relationships among these stakeholders were organized and candidate service providers selected.

In FY2019, we conducted interviews with the mapped candidate businesses to understand their level of interest in and sympathy with the world view and service contents that the portal was aiming to provide, their level of interest in and confidence in their own business using the portal, and their requests for the portal's functions and data handling, with

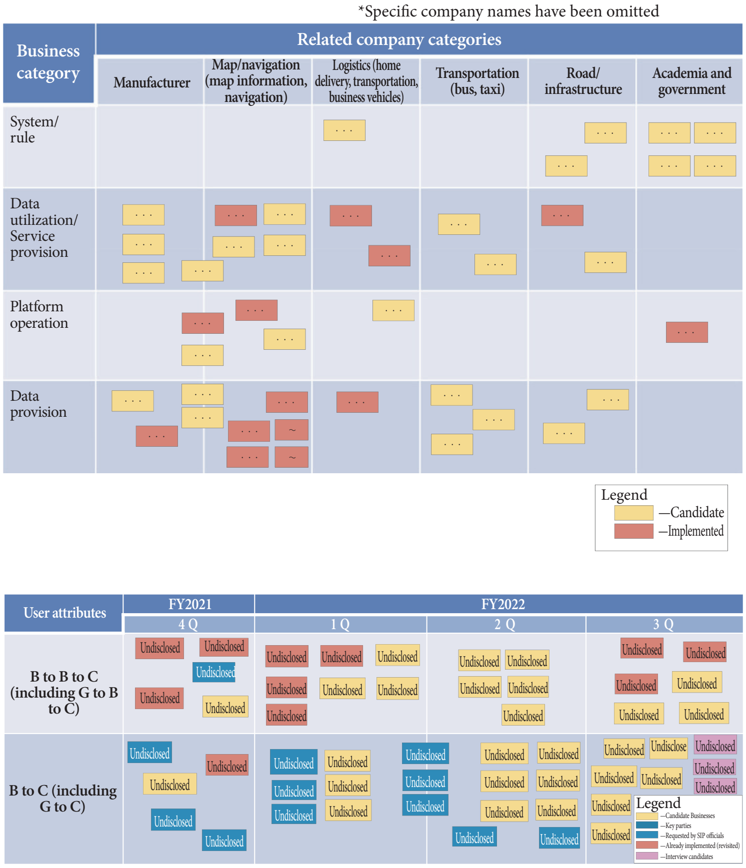


Fig.6: Mapping of candidate businesses

the aim of utilizing them in future promotion activities and portal site functions. Through these interviews, we were able to obtain suggestions for future development of portal functions and promotion activities such as portal site management, which we fed back into the development of the portal site and made an issue to be considered in the next fiscal year. In FY2020, we considered the importance of aggregating road traffic environment data from various companies and publishing it as catalog data, so we decided to approach potential data providers. As a result, we were able to obtain membership from nine companies and two organizations that support the MD communet initiative. After the public release in FY2021, in parallel with promotional activities for the MD communet, we actively approached data providers that possess characteristic road traffic environment data, and the data users and data processors who are necessary for creating services. As a result of various promotional activities, we were able to increase the number of members to over 60 companies. (Fig.7)

More than 7,000 items of catalog data were obtained via the provision of catalog data from members. In addition, through continuous efforts to reach out to business operators, we were able to obtain the prospect of acquiring advanced data such as vehicle probe data. We were able to include characteristic public-private sector catalog data, including a wide variety of vehicle probe data and cross-sectional traffic volumes provided by the National Police Agency.

Fig.7: List of MD communet members (partial)

2.3. Activities to raise awareness

In FY2020, we also actively produced content and conducted various promotional activities to raise awareness and interest in MD communet in preparation for the release of the portal site.

First, in conjunction with the release of information in October 2020, a promotional website was created and released as a tool to introduce MD communet to candidate businesses and to gain widespread recognition and interest in the future development of the site. (Fig.8) The purpose of this website was to inform visitors about the value and functions of the portal site and to motivate them to register as members. The portal site was designed to provide an overview of the services offered, catalog information, use cases, support details, membership registration methods, and other information as the entrance to the data catalog, so that visitors can understand the services and be guided to membership registration and inquiries after becoming interested. In designing the site, we aimed for a site structure with a UI that would not be bothersome for both users who know about MD communet and those who don't. After the release of the site, we worked to increase awareness through various press releases and linkage with the SIP-adus program-related websites, and also used the website as an introductory tool when conducting promotional activities.

Fig.8: Promotional website

Next, a promotional video was produced to promote understanding of MD communet. (Fig.9) In addition to being aired at various events, the video was released on the SIP-café website, and was intended to attract interest and lead people to the promotional website. This led to an increase in the number of visitors to the website from SIP-café, which in turn led to an increase in the level of recognition.

Fig.9: SIP-café news release

In addition to the production of the above content, activities aimed at raising awareness of MD communet through events were held. (Fig.10) In order to increase awareness of MD communet and appeal to the possibilities of using mobility data, events were held using idea generation in a semi-closed environment to rediscover the value of mobility data, experience idea generation methods, and meet with potential future partner companies. With the cooperation of the Graduate School of System Design and Management at Keio University, a wide range of companies involved in the mobility industry shared various ideas through lectures and workshops. The event also created opportunities for interaction among the companies, and provided the possibility of matching companies at the event.

Fig.10: Examples of past events

2.4. Toward social implementation from FY2023

In order to continuously promote the creation of new data-driven businesses in MD communet, we will take both cyber and real approaches to the issues and concerns that members have in creating services by utilizing data, and provide the necessary matching and technical support for the creation of said services. At the same time, MD communet will continue to expand its membership and promote data utilization by sharing use cases to help people visualize data utilization and by communicating the value of MD communet in an easy-to-understand manner. Both cyber and real support will be provided. We will continue to operate and grow a system that can promote the wider distribution and service utilization of road traffic environment data, as a platform that can be promoted through public-private partnership.

3 Testing Project Promotion

3.1. Overview

Based on the architecture pertaining to geographic data in the field of automated driving, we conducted FOTs (Field Operational Tests) using use cases to solve social issues extracted from the study results of the FY2019 projects in the first phase of SIP-adus, "the field of services for logistics companies" and "the field of end-to-end multi-modal navigation services." As a result, we found the possibility for new value-added services through the exchange of data among users.

Furthermore, in FY2020, based on a survey of issues faced by the logistics industry, we extracted candidate data that can be used in cooperative areas related to the initiatives and issues of logistics companies, with the aim of collaborating and utilizing cooperative data in the logistics field that will lead to solutions to social issues common to the industry.

In addition, based on discussions with the participants for the research and testing project for improving logistics efficiency based on architecture utilizing information from vehicle probes and other sources, we examined the issues related to the usefulness and deliverability of the above data candidates and the concept of service creation using the portal and based on the direction of the problem solving.

From FY2021, we explored the scope of possible collaboration and utilization of vehicle probe data, which had been an issue related to the availability of data due to its high confidentiality. As a result, we were able to construct a scheme to link and utilize data by bringing together a digital tachograph manufacturer that generates vehicle probe data for data providers, a trading company that plans service creation for service providers, and a data-holding delivery company that has business issues for service users, and conducted FOTs to realize service creation. In addition, in order to further promote data coordination and utilization, we conducted testing that contributed to solving issues faced by local governments in addition to those faced by private companies.

3.2. Fots overview

(1) Creation of services through data utilization by FOTs participants

We set up use cases to solve social issues identified based on the results of the study in the first phase of SIP-adus, and participants led FOTs.

Regarding social issues, in "the field of services for logistics companies" we set the provision of a safe and secure driving environment for truck drivers, including the need to avoid dangerous routes when considering safe driving. In "the field of end-to-end multi-modal navigation services," we have set the goal of providing stress-free transportation support by combining personalized transportation means (including automated driving) with means of transportation and route guidance that match user's personal data and are flexible to changes in weather and congestion conditions.

The purpose of the "services for logistics companies" is to verify the extent to which the use of the road traffic environment data portal can provide value, such as providing a safe and secure driving environment and improving the working environment, through data and data utilization methods that data users might have been unaware of. In line with this objective, we conducted a demonstration of an application for cooperative provision and utilization of geographic road traffic environment data among users, as shown in Fig.11 Interviews were conducted with truck drivers, operation managers with truck driving experience, and traffic information service providers.

The purpose of the "end-to-end multi-modal navigation services" was to verify that by using a road traffic environment data portal, it is possible to provide support for a more stress-free form of mobility that includes more personalized means of transportation (including automated driving) by providing dynamic information through data and data utilization methods that data users might have been unaware of. To achieve this objective, we set up an FOTs scenario incorporating multiple use cases and conducted functional evaluation and problem identification by having participants in the experiment use a service application that implemented all use cases, as shown in Fig.12.

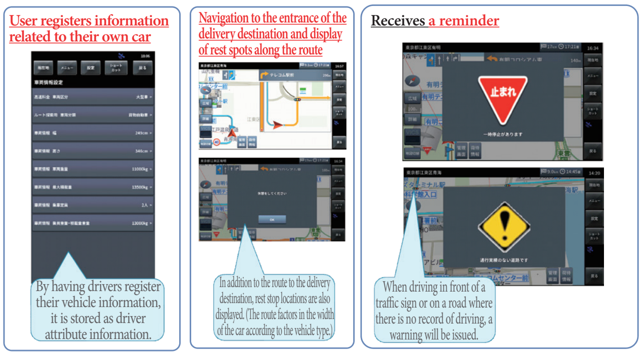


Fig.11: The field of services for logistics companies

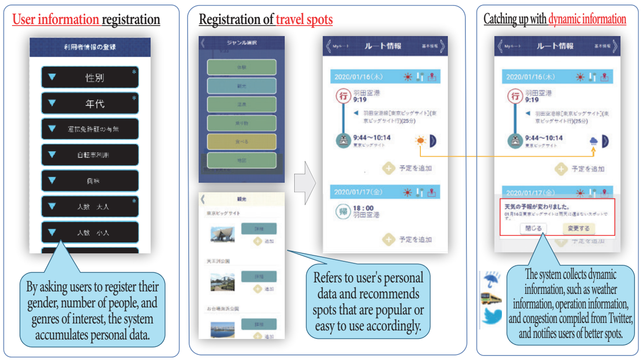


Fig.12: The field of end-to-end multi-modal navigation services

As a result of the FOTs for the services for logistics companies, we confirmed that route guidance that takes into account static information such as the provision of a safe and secure driving environment for truck drivers, loading docks, rest areas, road information, and traffic signs, especially on unfamiliar routes or routes where the road environment has changed, can contribute to improvements. Regarding the usefulness and scope of the cooperative area data, we confirmed that the data is useful as a cooperative area for public purposes, and that there are cases where there are significant advantages to sharing the data depending upon its nature.

In the FOTs for the "end-to-end multi-modal navigation services," we implemented a function that provides flexible transportation and route guidance in response to changes in dynamic information such as weather and congestion conditions, while also taking into account information such as user's personal data. In addition, the information collected via the application, such as the results of actions taken and the time spent in the area, can be effectively used as cooperative area data for marketing and other purposes. We therefore uncovered the possibility for data utilization in other fields via data in the cooperative domain being distributed through the portal.

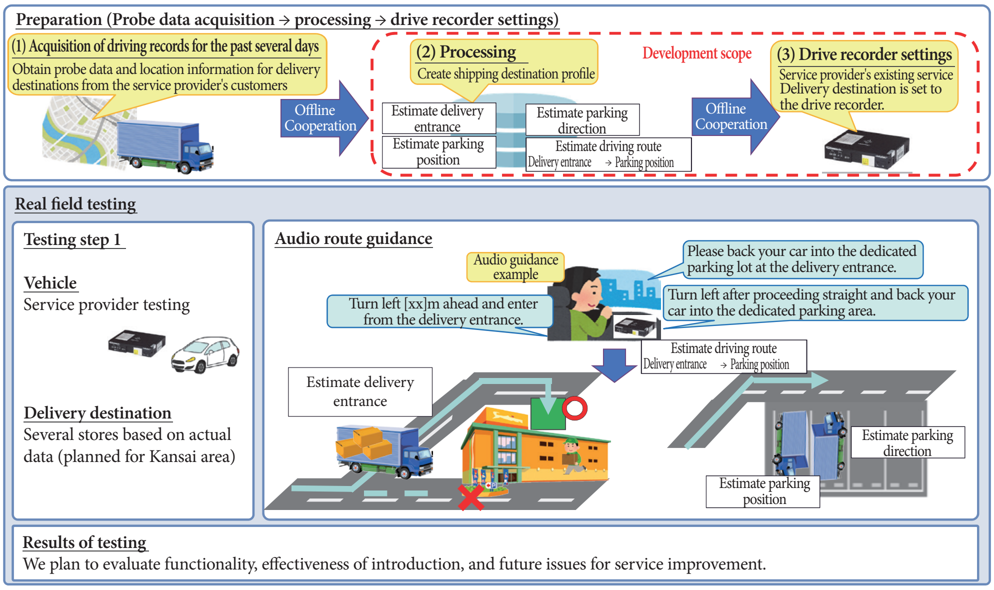


Fig.13: Overview of delivery destination profiling test

(2) Testing of vehicle probe data coordination and utilization among private companies

A digital tachograph manufacturer, a trading company, and the operator of MD communet collaborated to propose the creation of a service utilizing vehicle probe data for delivery companies (data holders), who are the direct customers of digital tachograph manufacturers, for the purpose of improving the efficiency of delivery companies' operations. Although the high confidentiality of vehicle probe data posed problems regarding its availability, permission to use the data was obtained for the sole purpose of using it to improve the efficiency of customer operations.

In setting the issues of delivery service providers, among the issues recognized by the digital tachograph manufacturer and trading company, we selected issues related to operational efficiency that also have a high affinity with vehicle probe data, such as the positions of delivery entrances and parking lots at delivery destinations not being organized and drivers having to park multiple times or drive around the perimeter.

The content of the FOT was to analyze and process the vehicle probe data to detect the location of the delivery entrance, parking location, parking direction, and route from the delivery entrance to the parking location for each store at the delivery destination, manage them as delivery destination profiles, and test whether the information provided to drivers can contribute to operational efficiency. (Fig.13) The analysis/processing of the vehicle probe data was conducted from the standpoint of service development support, which is one of the roles of MD communet management.

As a result of the FOT, we were able to confirm the usefulness of vehicle probe data in this area by confirming the contribution to a certain degree of operational efficiency and the issues that need to be addressed for practical application. We also confirmed the usefulness of planning support and data processing support in the process of service creation as part of MD communet operation.

(3) Resolving issues faced by local governments

In order to further promote data coordination and utilization, we examined the possibility involving not only private companies but also local governments and using geographic data to resolve issues faced by local governments. Based on the characteristics of data utilization, we selected the theme of utilization in EBPM (Evidence Based Policy Making) for local governments, and examined a plan to generate and utilize objective evidence by combining multiple instances of geographic data.

Specifically, we investigated in depth the issues related to snow removal and snow clearance in Yokote City, Akita Prefecture, a problem shared with every region that suffers from heavy snowfall, and the issue of illegal cab parking in Kyoto City, Kyoto Prefecture, a problem shared with other tourist destinations, and established use cases to solve these issues using geographic data.

3.3. Common efforts through testing

Through the testing, we found that the creation of services by combining multiple geographic data sets required technical know-how to handle data in different formats at the same time.

In order to continue to create services in the future, it is necessary to lower the hurdles mentioned above. We believe it would be possible to speed up development and reduce costs related to data utilization in the next and subsequent years by creating a template as a general-purpose function for processes, such as importing and processing, allowing for the handling of data of different formats simultaneously, as

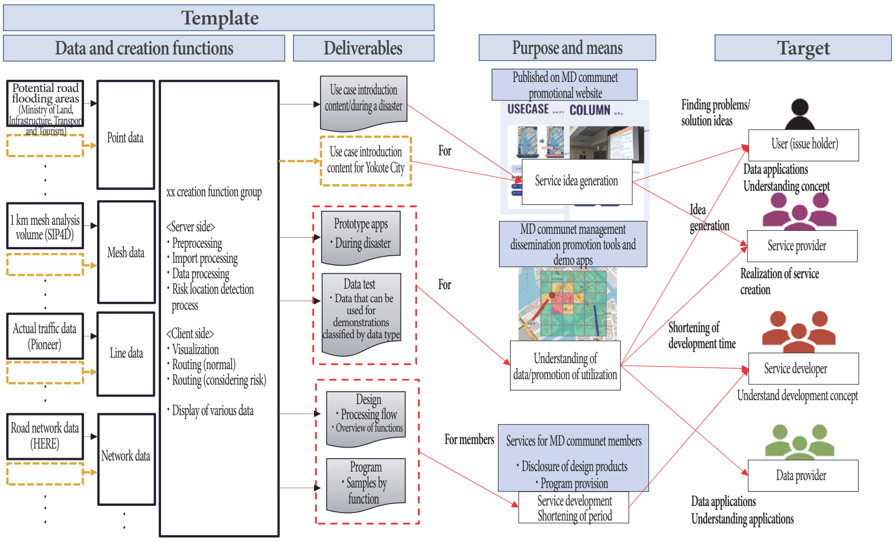


Fig.14: Geographic data utilization templating study

shown in Fig.14. We then created a design and program based on this idea.

In addition, because there were cases in which users were not able to start using geographic data because they did not have a clear image of what the data would be used for, we created a demo application that allows users to experience what the data can do.

4 Future Initiatives

In FY2022, the final year of the second phase of SIP-adus, we carried out activities focused on preparations for social implementation. After the second phase of SIP-adus ends in FY2023, MD communet will see social implementation. After social implementation, the MD communet will continue to serve as a hub for public-private partnerships and continue the various activities that have been implemented during SIP-adus. This is expected to increase the number of allies, promote further utilization of data and creation of new services, and solve social issues.

[Contacts]

NTT DATA Corporation, Smart Business Management Department, Social Innovation Division, Social Infrastructure Solutions Business Headquarters, Toyosu Center Building, 3-3-3 Toyosu, Koto-ku, Tokyo 135-6033, 050-5546-2450, Contact: Ayako Nakajima

2) Resolving Social Issues in Cities Popular with Tourists

Noriyuki Hayashi, Naohisa Komiyama, Yurie Toyama, Takahiro Kashiwa, Hiroki Ozu, Wataru Uchida (Mitsubishi Research Institute, Inc.), Kazuhiro Noguchi, Taro Morita, Natsuha Makino, Taigo Mitsuhara (MRI Research Associates, Inc.)

(Abstract) From the perspective of creating use cases to solve transportation-related issues in urban areas by utilizing road traffic environment data, we held a contest (an App Contest to Solve Tourism and Transportation Issues (the "Kyoto Raku Mobi Contest") to solicit applications and ideas to solve social issues related to tourism and transportation faced by Kyoto City, a world-class tourist city with many tourist resources. The contest was conducted with the cooperation of the Kyoto Municipal Transportation Bureau and businesses involved in transportation, logistics, and tourism, and organized and provided data including data on stations, stops, routes, schedules, and fares of buses, trains, and other public transportation systems; data on services and stores for temporary baggage storage and delivery services in the logistics sector; and information on tourist facilities and locations, past congestion statistical data and future congestion forecast data, and map APIs in the tourism sector. Through the implementation of the contest, we raised awareness of the portal site for road traffic environment data, and through discussions and coordination with the various involved parties, we realized the collection and utilization of data to be posted on the portal site (MD communet®).

Keywords: public transportation data, GTFS-JP, tourist city, app contest, MD communet

1 Overview of the Project

The SIP-adus (Cross-ministerial Strategic Innovation Promotion Program (SIP) Automated Driving for Universal Services) is working on the generation and distribution of road traffic environment data that is indispensable for automated driving, toward the realization of an automated driving society. This project took place in the tourist city of Kyoto and aimed to build an ecosystem that promotes matching between information owners and users so that a variety of users can use road traffic environment data in a variety of services. Specifically, the project planned and conducted two "Kyoto Raku Mobi Contests," an App Contest to Solve Tourism and Transportation Issues, and coordinated the development and procurement of road traffic environment data for use in the contests, with the aim of building momentum for the utilization of the data.

2 1st Kyoto Raku Mobi Contest

2.1. Planning and Preparation to the Launch (FY 2019)

Based on the assumption of several use cases for solving issues related to the movement of people and goods in urban areas, we considered the planning of the "Kyoto Raku Mobi Contest" as an app contest to solve issues using road traffic environment data (various data on transportation, logistics, and facilities), with the city of Kyoto, which faces issues concerning tourism and transportation in particular, as the subject.

In the consideration of the use cases, multiple use cases were considered for services related to transportation and logistics in urban areas, targeting various entities with different attributes (residents, tourists, government and transportation operators, etc.). Specifically, use cases that apply to tourists were considered, for example, (1) guidance of sightseeing routes that avoid the traffic flows of residents, (2) the recommendation of "empty-handed sightseeing" in which tourists can store their luggage, (3) suggestions of destinations that include congestion forecasts, and (4) guidance services that take into account congestion conditions and transportation service operation conditions. (Fig.1)

Based on the consideration of the use cases, various data that could be used to solve issues related to transportation and logistics in the tourist city of Kyoto were organized into the three categories of "transportation," "logistics," and "facilities", and an explanation of the purpose of the project and a request for provision of the data was made to the relevant parties such as the entities that hold such data, and the necessary data was procured.

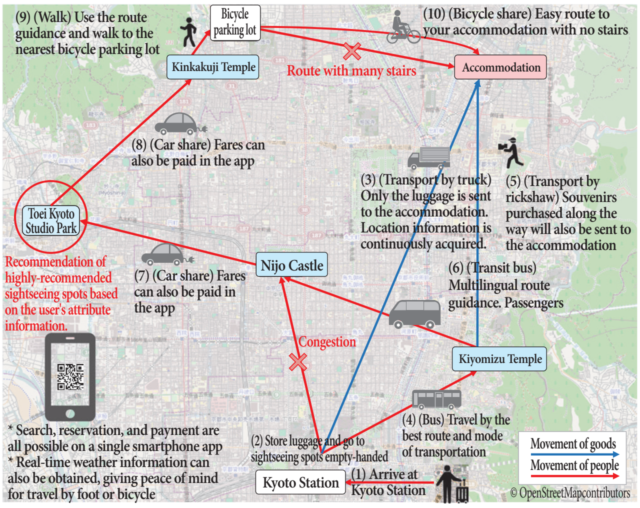


Fig.1: Example of use case study (tourist case)

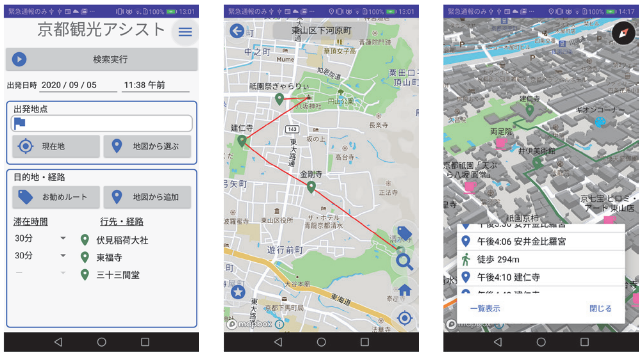


Fig.2: "Kyoto Tourism Assist" (tentative name)[1]

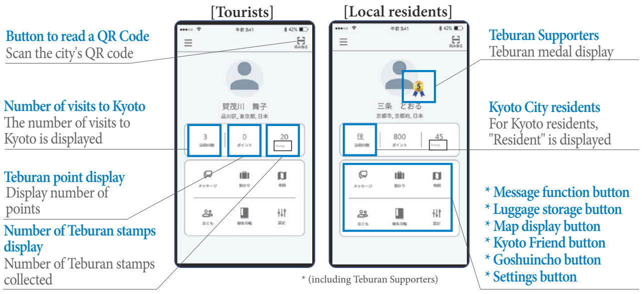


Fig.3: "Teburan - The app that makes you want to walk around empty-handed"[2]

2.2. Contest Management to Judging and Awards (FY2020)

Based on the above consideration, the "Kyoto Raku Mobi Contest" was planned and held from February to November 2020 to solicit apps and ideas that would contribute to solving tourism and transportation issues in Kyoto City. In addition to providing contest participants with road traffic environment data and APIs, we explained the contents and specifications of the data, conducted lectures and opinion exchanges on issues related to transportation and tourism in Kyoto City, and provided mentoring to individual contest participants.

The "Kyoto Raku Mobi Contest" consisted of two divisions, the app development division and the app idea division, and called for app products or ideas that contribute to solving issues in Kyoto. After conducting a documentary review of the submissions and testing and evaluation by monitors, we held a final judging session on Saturday October 17, 2020 and awarded seven prizes at an award ceremony on Saturday November 7, 2020.

The "Walking Town Kyoto Award" for the top prize in the app development division was awarded to "Kyoto Sightseeing Assist" (s name) (Fig.2), an app that supports the sightseeing activities of visitors to Kyoto by utilizing various road traffic environment data, including data based on the "General Transit Feed Specification Japan" (GTFS-JP) provided by the secretariat. The "SIP-adus Award" for the top prize in the app idea division was awarded to "Teburan - an app that makes you want to walk around empty-handed" (Fig.3), which was an idea for an app that discovers and provides new value of sightseeing spots when visiting empty handed. Subsequently, meetings were held with the creator of the winner of the "Walking Town Kyoto Award" for top prize in the app development category, and work was commissioned for the completion of the app towards social implementation.

3 2nd Kyoto Raku Mobi Contest

3.1. Planning and Preparation (FY2021)

Since FY2021, a portal site (MD communet) for searching and matching data related to road traffic environment data has been built and its use has commenced. As an example of solving a regional issue using road traffic environment data, the planning of the "2nd Kyoto Raku Mobi Contest" as a contest to promote data utilization using MD communet was studied, with the aim of forming an ecosystem for data provision and utilization in the tourist city of Kyoto.

In this contest, contest participants were asked to set and specify an issue that the contestant expected to resolve themselves and which targeted local residents, tourists, logistics, transportation, or tourism businesses, or local governments, and propose an app or idea that would solve the issue. As described below, the types of road traffic environment data provided in the contest was expanded, so unlike the first contest, the issues (use cases) expected to be resolved were not limited to specific items. Local governments and businesses involved in the contest were asked to propose "example issues" from the perspectives of public transportation, the region, tourism, logistics, etc., and the information was disseminated to the contest participants.

As in the first contest, data for the second contest was organized into the three categories of "transportation," "logistics," and "facilities," and we then coordinated and procured data from entities that possess such data in order to further expand the types of data.

Among these, for transportation data, we collaborated with Kyoto City to develop data from transportation operators so it could be provided in a standard data format (e.g., GTFS). In addition to utilizing GTFS-JP, which was developed on a trial basis for the future openness of bus data by transportation operators, dynamic data such as the location of buses and trains was developed and distributed on a trial basis. (Fig.4)

Transportation sector		
Data contents	**Data provider**	
Data on Kyoto Municipal Subway stations, routes (lines), timetables, fares, etc.	Kyoto City Urban Planning Bureau	GTFS
Data on Eizan Railway stations, routes (lines), timetables, fares, etc.	Eizan Electric Railway Co., Ltd.	GTFS, GTFS-RT
Data on Kyoto Municipal Bus stops, routes (lines), timetables, fares, etc.	Kyoto City Urban Planning Bureau	GTFS-JP
Kyoto Municipal Bus vehicle location API	"Walking Town Kyoto" Bus and Train Transfer Information Dissemination System Consortium	
Kyoto bus stops, routes (lines), schedules, and fares	Kyoto Branch, JTB Corporation	GTFS
Data on Yasaka Bus stops, routes (lines), timetables, fares, etc.	Yasaka Bus Co., Ltd.	GTFS-JP, GTFS-RT
Data on Kyoto Municipal Bus vehicle locations, etc.	"Walking Town Kyoto" Bus and Train Transfer Information Dissemination System Consortium	
Kyoto City Park-and-Ride Parking Lot data	Kyoto City Urban Planning Bureau	

Fig.4: Road traffic environment data (traffic data) provided by the secretariat in the second contest

We also coordinated so that the secretariat could provide data on logistics, facilities, and tourism.In particular, it was decided to expand the data in the field of logistics by collaborating with providers of data already available on MD communet. (Fig.5)

The field of logistics			
Data contents	Data provider	Data format	Location of data provision
Location data (individual vehicle point sequential data) and origin and destination data of logistics vehicles in the 100 square kilometers of the main area of Kyoto City	Yazaki Energy System Corporation	CSV	MD communet
Sensing Core (Kyoto Office)	Sumitomo Rubber Industries, Ltd.	(To be published in the future)	(To be provided in the future)
Vehicle driving data (statistics)	Aioi Nissay Dowa Insurance Co., Ltd.	CSV	MD communet
The field of facilities and tourism			
Data contents	Data provider	Data format	Location of data provision
Kyoto City sightseeing spot information	Kyoto City Tourism Association (DMOKYOTO)	XLSX	MD communet
Congestion forecast information around popular tourist spots	Kyoto City Tourism Association (DMOKYOTO)	XLSX	MD communet
Information on Wi-Fi spots in Kyoto City	Kyoto City Tourism Association (DMOKYOTO)	XLSX	MD communet
Data (estimates) on human flows around tourist attractions in Kyoto City (2nd Kyoto Raku Mobi Contest)	Yahoo Japan Corporation	CSV	MD communet
Location guidance service API	Zenrin Co., Ltd.	API	Other data
Data on temporary baggage storage and delivery service stores and coin-operated locker locations	Secretariat of the 2nd Kyoto Raku Mobi Contest	CSV	Other data

Fig.5: Road traffic environment data (logistics and facility data) provided by the secretariat in the second contest

In the second contest, the website and contents were designed to encourage participants to be aware of and use MD communet. In collaboration with NTT Data, a link to MD communet was placed on the contest's website and related content was posted in the "Events" and "Columns" sections of MD communet as reference information for participants. In

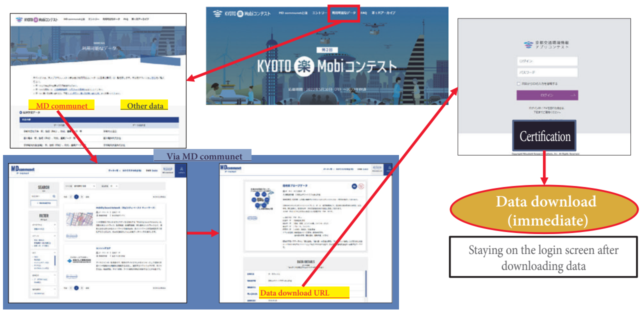


Fig.6: Cooperation between the contest and MD communet[(3)(4)]

addition, we coordinated a policy that the road traffic environment data provided in the contest would in principle be posted in the MD communet catalog during the period of the contest. (Fig.6)

In addition, following on from the first contest, we coordinated with relevant entities including local data providers and local governments to involve them in the contest. In addition to Kyoto City as a cooperating entity, we expanded the number of sponsors, who were mainly local businesses in Kyoto.

3.2.Contest Launch and Operation to Judging and Awards (FY2022)

The "2nd Kyoto Raku Mobi Contest" was planned and implemented taking into account the above consideration. As with the first contest, it consisted of two divisions, the app development division and the app idea division, and called for app products or ideas that contribute to solving issues in Kyoto.

A press release regarding the second contest was sent out and entries were accepted from Monday, April 25, 2022. Road traffic environment data and mentoring was provided to contest participants to encourage them to consider submitting entries.

Entries were closed on Monday, October 24, 2022, and the submission period closed on Monday, October 31. A document review was conducted and the final judging and awards ceremony was held on Sunday December 11, 2022. As with the first contest, awards were given including the "Walking City Kyoto Award (Kyoto Mayor's Award)" for the top prize in the app development division and the "SIP-adus Award (Cabinet Office Secretary-General of Science, Technology and Innovation Policy Award)" for the top prize in the app idea division, and it is planned to commission the winner of the "Walking City Kyoto Award" with the aim of social implementation within FY2022.

4 Outcomes of this Project

The app and ideas developed through this contest were a step toward the contest participants solving specific issues by utilizing road traffic environment data. Because the intellectual property rights concerning the entries in the contest in principle belong to the creators of the inventions, etc. (i.e. the contest participants), it is possible for them to continue their efforts toward social implementation after the contest has ended.

Through this project, discussions were held with local governments and data providers for the distribution and utilization of road traffic environment data in Kyoto, and was linked to the creation of momentum for the development and provision of data in standard formats, including dynamic data (e.g., GTFS-RT). In the future, it is necessary to promote discussions with the related entities so that data can be continuously developed and distributed in the region even after the contest is over.

[References]

(1) Teruki Matsuoka: Kyoto Raku Mobi Contest Submission Materials
(2) Team Teburan: Kyoto Raku Mobi Contest Submission Materials
(3) Mitsubishi Research Institute: 2nd Kyoto Raku Mobi Contest, https://web.contest.adus-arch.com/, (accessed on 29th August 2022)
(4) NTT Data: MD communet, https://info.adus-arch.com, (accessed on 29th August 2022)

[Contactts]

Mitsubishi Research Institute, Inc., Smart Region Headquarters, 10-3, Nagatacho 2-chome, Chiyoda-ku, Tokyo 100-8141, 03-6858-2722, Contact: Noriyuki HAYASHI

3)Research to Realize More Effective Logistics System with Probe Vehicle Data

Yukihiko Akao, Masaaki Kanazawa, Daijiro Sato (NX Logistics Research Institute and Consulting, Inc.)

(Abstract) This study conducted FOTs (Field Operational Tests) on data acquisition and utilization for three use cases: (1) ascertaining the occurrence of waiting time and sharing with related parties, (2) checking daily inspection items using vehicle data, and (3) measuring load weight and tire data to ensure legal compliance and safety, and identified the issues towards implementation and considered countermeasures, with the aim of utilizing various types of data related to vehicle and probe information to improve operational efficiency and ensure safety in truck logistics. Through the verification of the hypotheses via the FOTs and discussions with carriers and related businesses based on the results of the FOTs, each use case was evaluated highly from the perspective of its usefulness in improving the efficiency of trucking operations and ensuring safety. On the other hand, since each use case is still at the concept level and the considerations towards implementation are still in their infancy, it will take a considerable period of time before practical application, as there are various technical, business, and legal issues to be addressed in the detailed considerations. In order to create the environment and momentum towards practical application, it is necessary to promote awareness of each use case and to create related organizations and businesses that will serve as promoters.

Keywords: trucking operation efficiency improvement, transportation operation safety, waiting time, daily inspection, load weight, tires, vehicle signal data

1 Outline of the Study

1.1. Contents of the Study

In this study, FOTs using vehicle and probe information for three use cases were conducted, and the issues to be addressed towards implementation and who will be in charge of future promotion were considered, with the aim of utilizing various data, including vehicle and probe information, to improve operational efficiency and ensure safety in truck logistics, with a view to the practical application of automated driving technology in truck logistics in the future.

The three use cases are: (1) ascertaining the occurrence of waiting time and sharing with related parties, (2) checking daily inspection items using vehicle data, and (3) measuring load weight and tire data to ensure legal compliance and safety. Through the test study of these use cases, the extent to which the acquisition and utilization of vehicle and other various data can be achieved at present was confirmed. Based on this, identifying the image of the final goal and the issues to be addressed with the aim of practical application of these initiatives in the future, as well as consideration of the roles to be played in promoting future implementation, are in progress.

This study is scheduled to be completed by the end of December 2022 and is still in the process of discussion and examination at the time of writing this report. This paper is based on the results of the FOTs and considerations up to the end of August 2022.

1.2. Background of the Study

The truck logistics industry is facing a growing shortage of truck drivers due to working environment problems such as long working hours. There is concern that this will have a negative impact on the Japanese economy, as logistics will not be able to adequately meet the future demand for freight transportation. One effective solution to this problem is expected to be the practical application of automated driving to truck logistics in the future.

On the other hand, inefficient truck logistics operations, such as long waiting times before loading and unloading, are a typical example of the background to the working environment problems of truck drivers. This inefficiency problem cannot be fundamentally solved by automated driving, so the factors should be analyzed and countermeasures should be considered separately from automated driving.

It is also true that there are safety and maintenance concerns regarding the practical application of automated driving in truck logistics, and it will be necessary to consider maintenance measures and safety assurance measures for a new era based on the assumption of saving manpower through automated driving.

In considering how to address these issues, we became aware of the problem of whether the use of vehicle and probe information can be linked to concrete measures. Based on this awareness, three use cases were studied and FOTs were conducted with the aim of correcting inefficiencies and ensuring safety in truck logistics operations.

1.3. Positioning of This Study with a View to Implementation

Three FOTs were conducted to confirm the present technical feasibility of the concepts related to the use cases and to evaluate their usefulness in operational practice by gathering the opinions of carriers. Therefore, the FOTs and considerations related to the three use cases are still in the early stages of technological consideration, and there are various issues that need to be addressed before they can be materialized and implemented in the future. This study will present the main issues that need to be addressed for practical application of each use case. In addition, it is planned to explain each use case to entities and government agencies and request them to consider measures to deal with these issues and promote their practical application, and to encourage them to implement promotion measures.

2 Details of the FOTs for the Three Use Cases

2.1. Ascertaining the Occurrence of Waiting Time and Sharing Among Related Parties

2.1.1. Details of the FOTs

This is an initiative to collect and analyze information to study measures to reduce waiting time for cargo by utilizing information obtained from information terminals installed on trucks owned by trucking companies and from their in-house systems, with the aim of improving productivity and long working hours at logistics sites. Specifically, the occurrence of waiting time for each vehicle, work day, pickup location, and delivery location is confirmed by collecting and analyzing the operation management data of trucks in actual operation, and vehicles and locations where long waiting times (i.e., waiting 30 minutes or more at one location) frequently occur are identified. The usefulness of sharing the data which identifies the actual status of waiting times between carriers and shippers in promoting initiatives to reduce and improve long waiting times was tested.

According to the Ministry of Land, Infrastructure, Transport and Tourism's "Survey of Truck Transportation Conditions" (2021), drivers spend 94 minutes waiting for cargo during each operation (12.6% of the total time per operation). Assuming 200 workdays per year, the annual waiting time is estimated to be about 310 hours. Reducing such unproductive waiting time is essential to improve the long working hours of drivers.

To this end, it is necessary for shippers and carriers to share an awareness of the actual conditions of waiting for cargo, such as "how many times long waiting occurs at which pickup/delivery locations," and to discuss the causes of such waiting and implement improvement measures. However, shippers are generally unaware of the occurrence of trucks waiting to carry the shipper’s cargo. On the other hand, many carriers do not accurately ascertain and record the time spent waiting for cargo at pickup and delivery destinations, and are not able to communicate the actual status of waiting to shippers.

Therefore, we believe that the first step needed towards reducing waiting time is to ‘visualize’ the actual status of waiting time as numerical data and to have a common understanding between carriers and shippers. Based on this idea, this testing project analyzed the occurrence of waiting time based on the operation management data from the digital tachographs of trucks used in actual operation, and presented this data analysis to the carrier and their shipper, and discussions were held to attain mutual recognition about the status of waiting time as well as consider the causes of waiting and improvement measures. The ultimate goal is to reduce the waiting time at each location to less than 30 minutes through the spread of these initiatives.

The subject of this test study was processed food products, which have particularly long waiting times. With the consent of a transporter that mainly handles processed food products, and their largest customer who is the shipper of the goods, operation management data related to the transportation and delivery of cargo from the shipper company was acquired and the occurrence of long waiting times for cargo was analyzed from this data. The results of the analysis showed that 374 (57%) of the 656 vehicles in operation during a two-month period waited for a load, and that the average waiting time (the average for the vehicles that waited for a load) was 43 minutes per vehicle per day, with a maximum waiting time of 5 hours and 46 minutes in one day. In addition, 157 vehicles (24%) waited for a long time, and the average waiting time for these vehicles was 1 hour and 23 minutes per vehicle per day. The destinations with an average waiting time of one hour or longer were listed (Fig.1), and the date and time of waiting was clarified for the destinations with particularly frequent waiting.

After explaining this and the other details of the analysis

Location	Total wait time	No. of occur-rences	Ave. wait time	Max. wait time	Date of max. wait time	Day
[illegible]	4:15	1	4:15	4:15	4/28	Thu.
[illegible]	7:13	2	3:36	3:50	3/19	Sat.
[illegible]	6:59	2	3:29	4:10	3/26	Sat.
[illegible]	3:00	1	3:00	3:00	4/16	Sat.
[illegible]	2:33	1	2:33	2:33	3/23	Wed.
[illegible]	1:55	1	1:55	1:55	4/28	Thu.
[illegible]	7:00	4	1:45	2:09	3/8	Tue.
[illegible]	14:54	9	1:39	2:50	3/5	Sat.
[illegible]	1:36	1	1:36	1:36	3/26	Sat.
[illegible]	1:35	1	1:35	1:35	3/11	Fri.
[illegible]	3:07	2	1:33	1:55	4/12	Tue.
[illegible]	10:34	7	1:30	2:51	4/6	Wed.
[illegible]	4:21	3	1:27	2:12	3/4	Fri.
[illegible]	1:27	1	1:27	1:27	4/27	Wed.
[illegible]	1:26	1	1:26	1:26	3/18	Fri.
[illegible]	2:51	2	1:25	1:55	3/2	Wed.
[illegible]	1:21	1	1:21	1:21	3/24	Thu.
[illegible]	3:52	3	1:17	1:55	4/4	Mon.
[illegible]	2:28	2	1:14	1:20	4/1	Fri.
[illegible]	6:03	5	1:12	2:47	4/20	Wed.
[illegible]	1:11	1	1:11	1:11	3/11	Fri.
[illegible]	4:43	4	1:10	1:51	3/7	Mon.
[illegible]	4:37	4	1:09	2:09	3/19	Sat.
[illegible]	10:10	9	1:07	2:17	4/14	Thu.

Fig.1: Analysis of locations, days of the week, and times with high waiting times

data to the transportation company that provided the data and the company that shipped the cargo, opinions were exchanged on the actual situation of waiting times and target sites, and are being used in the analysis of the factors behind long waiting times and the consideration of countermeasures.

2.1.2. Results of the FOTs and Future Issues

When we asked the carrier and the shipper that cooperated in this testing project for their opinions on the usefulness of the truck carrier sharing such data with the shipper, high evaluations were received such as, "we could numerically confirm the status of waiting for cargo, and also obtain new insights" and "it is very meaningful for both sides to share data that enables understanding of the overall picture of the occurrence of waiting times and exchange opinions", and the results showed that such visualization of the logistics on site can promote discussions between carriers and shippers to eliminate waiting time. In particular, there was an issue that it is difficult for the shipper company to proactively address drivers' long working hours because the waiting time occurred not at their own facilities but at the facilities of their customers and consignee destinations. If the sharing of data with truck transportation companies enables the shipper to approach the consignee for improvement based on specific data, the effectiveness of the system is expected to be very high, as it will lead to improvement efforts from both sides of the supply chain.

On the other hand, a problem that needs to be addressed for the implementation and spread of this initiative is whether carriers are capable of cleansing, correcting, analyzing and documenting the operation management data. In other words, the correction and analysis of operation management data requires a considerable amount of time on the administrator, placing a different burden on the carrier. In addition, many managers at carrier businesses may not have the experience or skills to analyze the data. This is the biggest issue for the implementation and dissemination of this use case.

2.2. Checking Daily Inspection Items Using Vehicle Data

2.2.1. Details of the FOTs

This is an initiative to verify the feasibility, usefulness, and issues of using truck vehicle and probe data to check inspection items, instead of checking by the driver, for the daily inspections carriers are obliged to perform by law before the start of operation.

It is estimated that the time required for daily inspections, etc. that carriers are obliged to perform is 25 minutes per operation, or approximately 83 hours per year. Although there are several items that cannot be confirmed via vehicle data, many carriers hope that even a portion of the time required for daily inspections can be made more efficient. In addition, the opinion was often heard that qualitative benefits such as the correction of variations in the level of daily inspections among drivers and a reduction in the psychological burden of drivers is expected. Furthermore, in view of the future implementation of automated driving, studying the reduction of the manpower required for daily inspections should also be progressed. An empirical investigation of this use case was conducted based on the awareness of the above issues.

The Japan Automobile Manufacturers Association (JAMA) has standardized the "data items provided by vehicle and probe data" and the "production rules for the API used by users to acquire data from the back-end of heavy-duty truck manufacturers" and progressing the establishment of a system that allows data users to acquire and use common data items from each truck manufacturer using the same API if the service menu is the same for that user. Based on this, how event data that contributes to the confirmation of daily inspection items can be extracted from vehicle and probe data, etc. was considered, assuming the use of the API.

First, daily inspection items that can be expected to be checked using vehicle and probe information were identified. Of these items, those that could be checked using vehicle signals that could be obtained from the vehicle model of heavy-duty trucks used for testing by the truck manufacturer that cooperated with the FOTs were selected as the target items for the FOTs. Specifically, the following eight items were selected.

(1) Parking brake signal, (2) Engine speed signal
(3) Accelerator pedal opening signal
(4) Windshield washer switch signal
(5) Windshield wiper switch signal
(6) Air tank pressure signal
(7) Cooling water low level signal

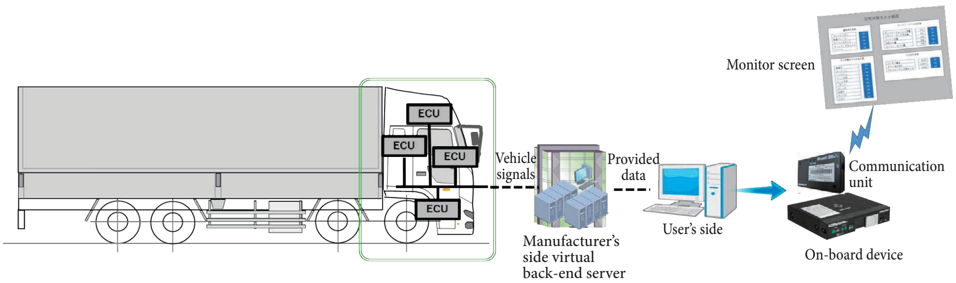


Fig.2: Diagram of vehicle data acquisition and on-screen display of daily inspection items

(8) Lamps and lights signals (vehicle width lights, front lights, tail lights, number lights,
turning indicators, emergency flashing lights, reverse lights)

In the FOTs, the truck manufacturer provided vehicle signal data for the above items. Fig.2 shows the sequence of this.

By using this vehicle signal data to display the items related to the FOTs on the monitor screen shown in Fig.3, the possibility of being able to use the truck vehicle signal data to confirm the related daily inspection items was confirmed.

Fig.3: Sample of a monitoring screen

2.2.2. Results and Future Issues from the FOTs

Using the vehicle data obtained from the vehicles used in the FOTs, the appropriateness of the relevant daily inspections could be determined by visually confirming their condition on the monitor screen. In addition, the disconnection of a brake light, which was intentionally reproduced as a malfunction, could also be confirmed on the monitor screen. Therefore, if vehicle and probe data utilization and API production rules are established, and if the provided data items can be utilized remotely on a monitor screen, it may lead to a reduction in the working hours and workload of drivers and maintenance managers.

According to our research, the time required for the eight items covered in this study accounts for approximately 40% of the total time required for daily inspections, and it is estimated that the expected reduction of annual time per person through implementation of this is approximately 32 hours. In the future, if truck manufacturers can provide data based on the API production rules (both ECU and actuator signals may be required depending on the daily inspection items), including other items related to daily inspections that could not be ascertained in the FOTs, the range of daily inspection items that can be inspected based on vehicle data will be expanded and the reduction in time required for the daily inspections can also be expected to increase.

Furthermore, if an algorithm is established that can automatically determine the suitability of the results of daily inspections from the vehicle data and the results are recorded electronically, it may be possible to replace visual inspections with inspections based on vehicle and probe data. As this is expected to help prevent accidents caused by failure to perform daily inspections, inspection errors and inadequate checking, it is therefore desirable to confirm consistency with laws, regulations, and public notices, and to consider any necessary revisions together with the establishment of the technology.

2.3. Measuring Load Weight and Tire Data to Ensure Legal Compliance and Safety

2.3.1. Details of the Load Weight Measurement FOTs

This is an initiative that verified the usefulness in preventing overloading, in which the driver measures the weight of the load using a load weight meter when loading and unloading during actual operation, and confirms the load weight data from the driver's seat, while the sales office manager also ascertains the relevant data via a terminal.

Overloading is an extremely dangerous practice that interferes with safe driving, such as braking and steering. For this reason, carriers generally take care to avoid overloading when loading and unloading cargo, but some shippers may deliver cargo to carriers without knowing the weight of the cargo, resulting in overloading. On the other hand, carriers cannot refuse to accept cargo from a shipper unless they have ascertained that the cargo will be overloaded.

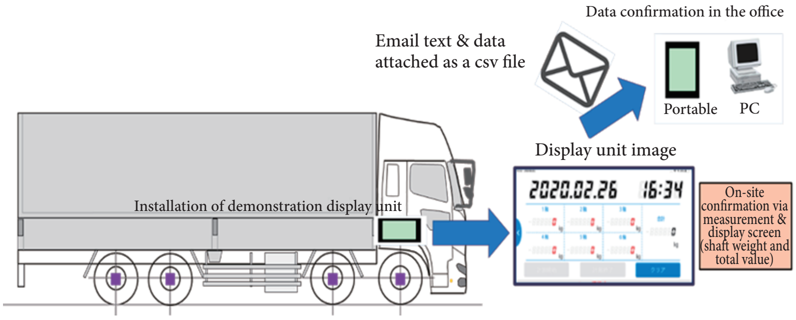


Fig.4: Diagram of loading weight measurement and checking

Based on this, the possibility of preventing overloading through the carrier using a load weight meter to ascertain the weight of loaded cargo and gross vehicle weight when loading the cargo at a delivery destination and keeping records of the results was verified. This initiative aims to prevent the occurrence of unintentional overloading in the course of operations.

In the FOTs, axle-weight sensors that measure the load weight and devices for checking and transmitting the load weight data were installed on four heavy-duty trucks used in actual operation. The drivers measured and confirmed the load weight each time they loaded and unloaded the trucks during operation. The measured load weight data was also sent to the sales office by email so that the manager could ascertain the data (Fig.4 shows an overview of this sequence). The above-mentioned measurement of load weight, data transmission, and confirmation by the driver and manager was repeatedly performed.

2.3.2. Results of the Load Weight Measurement FOTs and Future Issues

Through the above tests, it was confirmed that the load weight meter can measure generally accurate load weights. It was also verified that the driver can check the load weight data each time cargo is loaded or unloaded, and that the data was appropriately transmitted to the operation manager.

After the tests, interviews were conducted with the transport operator (managers and drivers), who gave a good evaluation of the load weight meter, including the following.

- For the operator, the load weight meter helped with safe operation by preventing overloading.
- For the operator, it is possible to use the data to negotiate rates with shippers.
- It is useful to be able to ascertain the axial weight on each axis.

On the other hand, it was pointed out that it is necessary to link with devices such as digital tachographs to save labor in operation and to arrange the sharing of data. In addition, an opinion was provided that, as it is assumed that data sharing will lead to collaboration in order to reduce drivers' working hours, this could lead to increased efficiency through matching and joint transportation and delivery. Another opinion was that the accumulation of load weight data will lead to management by shipper and vehicle, and that if the data can be linked to fuel consumption and mileage obtained from the vehicle's information, it will be possible to determine fuel consumption according to actual vehicle weight. In particular, many held the opinion that linkage with digital tachographs is desirable from the viewpoint of labor-saving device operation, centralized management of the terminals from which information to be checked by operation managers is obtained, and the effective utilization of data through linkage with fuel consumption and distance traveled, so it can be said that this is a main issue for the future.

2.3.3. Details of the Tire Data Measurement FOTs

In this initiative, as with the load weight meters, tires equipped with a TPMS were installed on heavy-duty trucks operated by four carrier companies to ascertain tire pressure and temperature data, and it was confirmed whether it is possible for this data obtained by the tire manufacturer's server could be shared with the carrier company's operation managers of the carrier companies.

Tire-related problems account for the largest number of vehicle breakdowns, and carriers have a strong awareness of the problem of tire maintenance conditions. However, matters related to tire condition that can currently be monitored using signal data are limited to air pressure and internal tire temperature, so the initial goal is to eliminate tire failures caused by poor air pressure maintenance (excluding those caused by sudden events or force majeure).

Both tire pressure and temperature values remained basically normal during the period of the FOTs, but a tire puncture occurred in one of the vehicles cooperating with the testing, and as shown in Fig.5, an alert was issued and the operation manager was notified by email when the tire pressure decreased below the threshold value. The operation manager noticed the email and contacted the truck driver, who stopped the vehicle and changed the tire on site. One mistake in the response could have resulted in damage to the vehicle and the spread of damage to the surrounding area due to scattering of tire fragments, but such damage was prevented and transportation time loss was minimized.

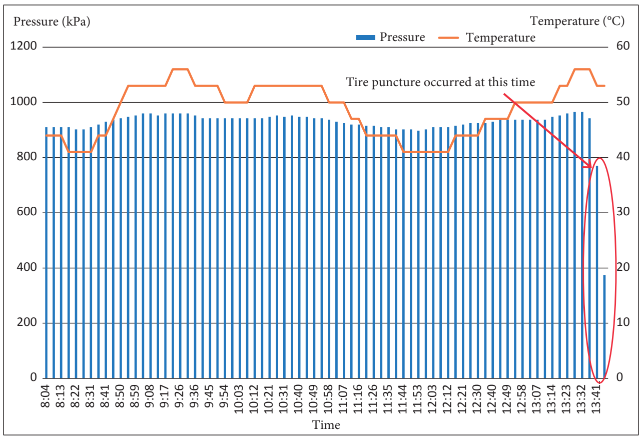


Fig.5: Data showing air pressure reduction at the time of the tire puncture

2.3.4. Details of the Tire Data Measurement FOTs

When interviewing the carrier companies regarding the load weight measurement, they were also asked about tire data measurement, and most considered tire maintenance to be the most important factor in preventing accidents, and they highly evaluated the usefulness of checking and managing tire conditions using data obtained while the truck is in motion. In addition, many of them expressed an expectation for the use of data on tire wear and predictive signs of wheel breakage as future tire data acquisition items.

On the other hand, as with the load weight meter, many held the opinion of wanting linkage with digital tachographs or a system to acquire tire data from digital tachographs. Also, others wanted a system for direct communication to the truck driver of information about the occurrence of an abnormality, and that frequent transmission of data is unnecessary and that notification only when an abnormality occurs or periodic provision of information once every few months would be sufficient.

3 Issues to Address to Promote Practical Application

3.1. Issues in Practical Application of the FOTs' Concept

As noted at the beginning of this paper, each use case is a work in progress, and there are various issues to be addressed in the future for their practical application.

The main issues are as follows.

3.1.1. Ascertaining the Occurrence of Waiting Time and Information Sharing

It is necessary to create a person in charge of organizing basic data for analysis and preparing data analysis materials. Regarding the analysis of waiting time, it is necessary to match the basic operation management data with other related data in order to correct the required time and occurrence location, but it seems that there are many carriers who find it difficult to perform such work and create analysis materials for the occurrence of waiting time. For this reason, it is necessary to promote the creation of a business operator (assuming a paid service) that can perform the task of organizing and analyzing data on behalf of carriers. It is also necessary to create an environment in which carriers can request such data analysis providers to prepare analytical data on the actual status of waiting time occurrence.

3.1.2. Checking Daily Inspection Items Using Vehicle Data

As mentioned above, JAMA has standardized the "data items provided by vehicle and probe data" and the "production rules for the API used to acquire data from the back-end of heavy-duty truck manufacturers" and progressing the establishment of a system that allows data users to acquire and use common data items from each truck manufacturer using the same API if the menu is the same for that user. This use case is based on the assumption that this mechanism will be established, and it is expected that this mechanism will be materialized first. It is strongly hoped that a wide range of vehicle signal data items related to daily inspection items, including items not included in these FOTs, will be selected as common data items provided by all truck manufacturers.

In addition, daily inspections must be conducted in accordance with the "Vehicle Inspection Standards" and "Guide for the Inspection and Maintenance of Motor Vehicles" established by the Ministry of Land, Infrastructure, Transport and Tourism. After confirming the consistency of the method of checking daily inspection items using vehicle data signals with these regulations, it is desirable to also discuss the revision of these regulations as necessary.

It is also desirable to establish an algorithm that can automatically determine the appropriateness of the results of daily inspections and to electronically record the results of such determinations in the future. Although these are long-term technological development topics, it is hoped that procedures for acquiring truck vehicle signal data will be established and put into practical use, and that the Vehicle Inspection Standards will be revised in the future, in order to create an environment in which each company can engage in research and development.

3.1.3. Measuring Load Weight and Tire Data to Ensure Legal Compliance and Safety

Regarding both of these, there is a strong demand from carriers to be able to obtain information centrally from digital tachometers and to be able to link it with other data, rather than obtaining the information independently. In this case, it is desired that it be possible to acquire and link data from the digital tachographs made by any company in Japan, and not just those made by a specific manufacturer.

In addition, regarding tire data, research and development initiatives are being performed to obtain information on tire wear and wheel breakage risks through linkage with truck vehicle signal data. The establishment and practical application of procedures for acquiring truck vehicle signal data by JAMA, as described in the previous section, is also an important issue for this research and development topic.

3.2. Necessity to Create Future Promoters Towards Practical Application

Regarding "ascertaining the occurrence of waiting time and information sharing", it is planned to consider ways to create a business entity responsible for organizing basic data and creating analysis materials, and to request the cooperation of truck carrier business associations in promoting awareness of this use case. Regarding "checking daily inspection items" and "measurement of load weight data and tire data", the exchange of opinions with related companies is being conducted so that it can be taken up as part of the specific items being considered in the "Logistics MaaS" promoted by the Ministry of Economy, Trade and Industry.

It is expected that both the private sector and business organizations, as well as the government and other public agencies, will support the implementation of all use cases.

[Contacts]

Department, NX Logistics Research Institute and Consulting, Inc., 2 Kanda Izumi-cho, Chiyoda-ku, Tokyo 101-0024

Research & Consulting Unit 1, (General, Tire Data Measurement) 03-5829-1423, Contact: Yukihiko Akao

Research & Consulting Unit 2, (ascertaining waiting time and information sharing) 03-5829-1405, Contact: Masaaki Kanazawa

Research & Consulting Unit 3, (Confirmation of daily inspection items, measurement of loading weight) 03-5829-1420, Contact: Daijiro Sato

4) Utilization and Application of Probe Data to Road Maintenance and Management

Hirokazu Ichikawa, Atsushi Takenouchi, Naohiro Uchiyama, Shinichi Nedu, Kazuki Tokunaga (Pacific Consultants Co., Ltd.)

(Abstract) This project was conducted for the purpose of studying potential generation of data that can be utilized in road maintenance and management, as well as information useful in automated vehicle driving, such as information related to poor weather and road conditions, based on probe vehicle data. As probe vehicle data used for studies, we take up data that can currently be acquired, such as ABS, traction control systems, Electronic Stability Controls, and windshield wiper operation data, and data that may be acquired in the future, such as road grip level data and water film thickness estimates. By grasping the correlation between probe vehicle data and various meteorological data that can grasp the precipitation and organizing in along the same units for each category, we plan to consider the potential for data generation and the effectiveness of this data in automated driving support and road maintenance.

Keywords: Probe vehicle data, road management, water film thickness, road conditions, vehicle control log

1 Purpose of project

During our researches in Section 3 3); Technological Development for Lane-specific Road Traffic Information Using Vehicle Probes, we improved the detection accuracy of the congestion tail for each lane by utilizing direction indicator information. As such, it may be possible to further utilize probe vehicle data. On the other hand, data on road conditions during rain and precipitation information may hold the key for use in road management operations support and information delivery for automated vehicles to issue a take-over request in enough time, as well as automated driving decisions in poor weather. Meteorological data provided in real-time has a resolution of 250 meter mesh units in High-resolution Precipitation Nowcasts. If it is possible to grasp road conditions and precipitation data from probe vehicle data received from commercial vehicles (OEM, etc.), it may be possible to utilize more detailed information.

This project aims to explore potential generation of data that can be utilized in road maintenance and management, as well as information useful in automated vehicle driving, such as information related to poor weather and road conditions, based on probe vehicle data.

2 Overview of deliberations

We extracted and studied probe vehicle data that may be able to detect status of water film due to rain and precipitation conditions, degree of danger in driving due to water films, and flooding to / roughness of, paved roads. Specifically, the following data was examined as probe vehicle data for our researches: data that can currently be acquired, such as ABS (Anti-lock Braking System), Traction Control System (TCS), Electronic Stability Control (ESC), and wiper operations information, and data that can be acquired in the future, such as road grip level data and water film thickness estimate value. We also studied potential utilization by testing the correlation of this probe vehicle data and various meteorological data and road conditions where the status of precipitation could be grasped. (Fig.1)

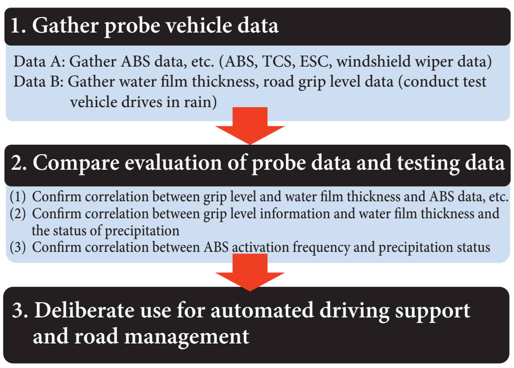


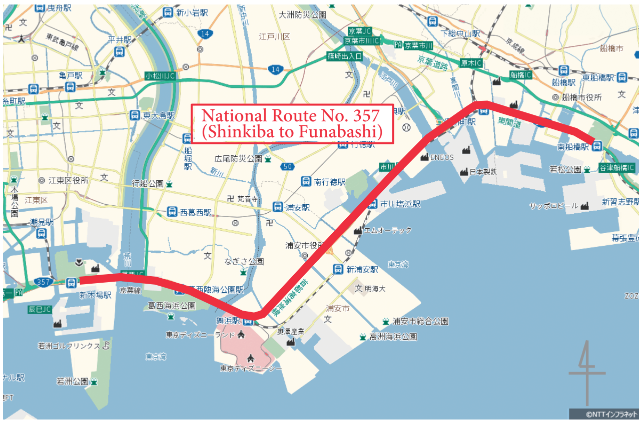
Fig.1: Research procedures

Further, the scope for gathering probe vehicle data, etc. and testing its potential utilization was No. 1 Haneda Line and Wangan Line (Fig.2) as expressway areas and National Route No. 357 (Shinkiba, Edo Ward to Funbashi City) (Fig.3) as a general road.

As a use case, support for road maintenance and management and automated vehicle driving is expected, as shown in Table 1.

Source: Added to ©NTT InfraNet

Fig.2: Target line (expressway area)



Source: Added to ©NTT InfraNet

Fig.3: Target line (general road area)

Table 1: Expectation of Use Cases

Automated driving support	・Grasp poor weather and road conditions early on, determine whether in or outside Operational Design Domain (ODD), and implement safety mechanism (to decelerate, implement early manual assistance requests, etc.)
Road management support	・Deliberate necessity of asphalt repairs (to prevent splashing pedestrians, extract areas that are easy to slip, such as sudden curves, etc.) ・Urge caution of flooding, etc. based on information boards, etc.

3 Gather probe vehicle data and meteorological data

Following is an overview of data needed to test the effectiveness of probe vehicle data utilization, data gathering techniques, and data organization examples.

3.1. Probe vehicle data

(1) Vehicle control records (ABS, TCS, etc.)

We gathered information (Table 2) on windshield wipers, ABS, TCS, and ESC activation, which are thought to change based on precipitation and the status of road water film, grasp the correlation between this data and precipitation amount, etc. and consider potential utilization for road management. We gathered the following data in the below period and locations.

- Data acquisition period: Four months from August to November 2022
- Data acquisition area: Two lines on Shuto Expressway (Haneda line, Wangan line)
- Data acquired: Number of passing vehicles that data can be obtained from, number of activations of wipers, ABS, TCS, and ESC in a 100 meter zone

Table 2: Overview of vehicle control devices

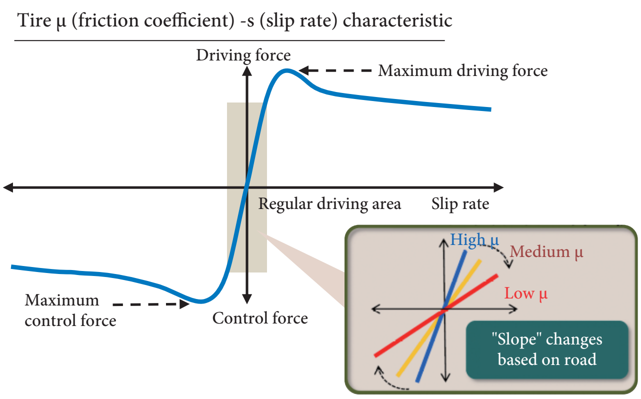
ABS	Quickly controls the degree of braking and prevents slips and spins on slippery roads due to rain or snow
TCS	Prevents tire slip that occurs at sudden acceleration on slippery roads
ESC	Prevent vehicle from going outside or inside lane when turning around curves

(2) Road grip level information

By analyzing the tire rotation signal, etc., it is possible to identify the status of grip with the road. The relationship between the slip rate and force differ based on the degree of slipperiness of the road (Fig.4). This slope is found from the tire rotation signal, etc. to detect the slipperiness of the road (road grip level). If a water film appears on the road due to rain, the road becomes more slippery. This data enables us to grasp the danger of potential hydroplaning. We have considered the usefulness of this information.

We acquired the data in the following period and locations by the following data acquisition method.

- Data acquisition period: Two months from August to September 2022
- Data acquisition area: Two lines on Shuto Expressway



Source: Materials provided by Sumitomo Rubber Industries, Ltd.

Fig.4: Road grip level estimate

(Haneda line, Wangan line) and National Route No. 357
- Data acquisition method: Acquire road grip level through driving vehicles in the rain with devices on-board that can acquire necessary data, such as tire speed signals, etc.

(3) Water film thickness estimates

We use the information of driving force of vehicles driving on roads to estimate the water film thickness. In addition to verifying estimate potential, we have grasped the correlation between estimated water film thickness and precipitation volume, etc. We acquired the data in the following period and locations by the following data acquisition method.

- Data acquisition period: Two months from August to September 2022
- Data acquisition area: Two lines on Shuto Expressway (Haneda line, Wangan line) and National Route No. 357
- Data acquisition method: Estimate water film thickness through driving vehicles in the rain with devices on-board that can acquire necessary data, such as driving force and resistance, etc.

3.2. Meteorological information

(1) High-resolution Precipitation Nowcasts

The High-resolution Precipitation Nowcasts is meteorological information provided by the Weather Service Support Center that aims to strengthen monitoring and forecast ability of localized heavy rain storms. It provides high precision and detailed radar images and precipitation volume forecasts. The data of High-resolution Precipitation Nowcasts include both rain rate intensity and five-minute rainfall rate. Utilizing both, we have grasped the relationship with the probe vehicle data.

- Data acquisition points: Four months from August to November 2022
- Data acquisition points: Rain volume gauges in National Route No. 357 zone (six areas)
- Data details: Rainfall rate intensity (mm/h), five-minute rainfall rate (mm)

(2) Roadside rain gauges

We gathered precipitation data acquired by rain gauges set up by road managers to ensure safe and smooth road traffic and grasp the relationship between it and probe vehicle data. The following data will be acquired in the following period and locations.

- Data acquisition period: Four months from August to November 2022
- Data acquisition points: Rain volume gauges in National Route No. 357 zone (six areas)
- Data details: Hourly precipitation (mm/h), Accumulated precipitation (mm)

4 Probe vehicle data and meteorological data comparison and evaluation

After organizing the gathered meteorological data and probe vehicle data so that units match in each zone, we have grasped their correlation. Specifically, we have conducted the following testing. (Fig. 5)

(1)Verify the correlation between the grip level information, the water film thickness, and the frequency of activation of ABS, TCS, and ESC

(2)Verify the correlation between grip level information, the water film thickness, and the status of precipitation

(3)Verify the correlation between frequency of activation of ABS, TCS, and ESC and the status of precipitation

In addition to the above, we used dashboard cameras and CCTV images to confirm the status of water film generation and grasp the appropriateness of water film estimate for the generation of actual water film.

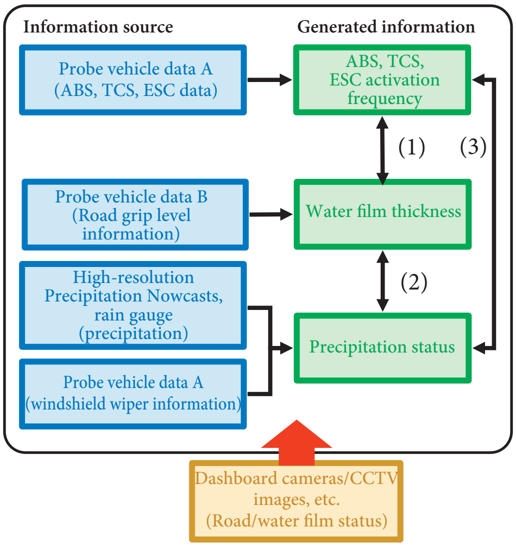


Fig.5: Information source and generated information

Fig.6 shows the relationship of the wiper activation detection rate every ten minutes of vehicles driving on the No.1 Haneda line and Wangan line and the precipitation during the rain on August 13, 2022. In this case, we can see a degree of correlation between the high-speed activation of windshield wiper

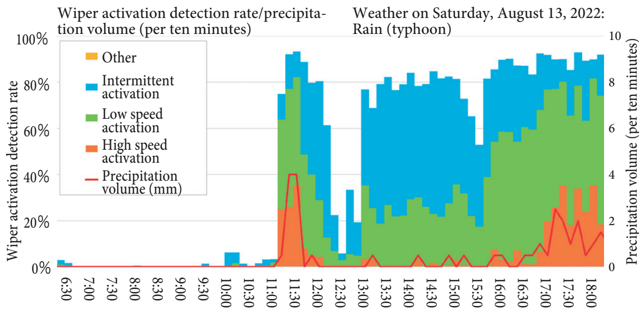
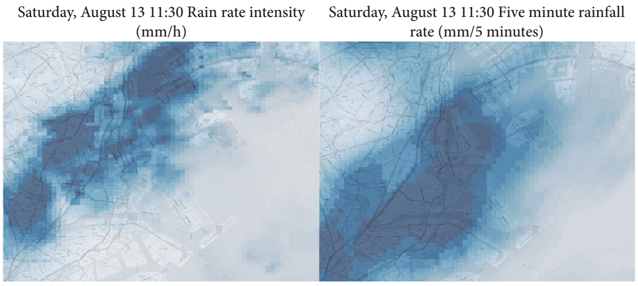


Fig.6: Windshield wiper activation detection rate/precipitation volume relationship example (Saturday, August 13, 2022)

activation detection rate and precipitation. However, wiper activation detection rate is a figure that applies to the entire target zone, while precipitation is a value observed in the Amadeus Haneda observation area. Potential correlation between windshield wiper activation detection rate and precipitation within a certain range has been presented. In the future, we will verify the localized correlation of other probe data using high resolution precipitation nowcasting, etc. shown in Fig.7.



Source: © OpenStreetMap contributors
Add data of Weather Service Support Center and High-resolution Precipitation Nowcasts in base map of https://www.openstreetmap.org/copyright

Fig.7: Examples of analysis data from High-resolution Precipitation Nowcasts (Saturday, August 13, 2022, 11:30 a.m., Left: Rain rate intensity, Right: Five minute interval of precipitation volume)

5 Conclusion

We plan to organize the acquired probe vehicle data and meteorological data for the 100 meter zone unit. After that, we will grasp the difference in the data acquisition status of probe vehicle data during rain and sun, verify the correlation with observed meteorological data, and attempt to grasp feasibility of information generation, detectable phenomenon by probe vehicle data, detection accuracy, and resolution. Based on these results, we are planning to organize data that can be utilized in automated driving support and road management.

[References]

(1) Japan Automobile Manufacturers Association: "Producing safer cars... Preventative safety techniques to prevent accidents..." https://www.jama.or.jp/library/children/encyclopedia/encyclopedia5.html (accessed 2022.08.30)

(2) Forecast Department, Japan Meteorological Agency: Technological information related to delivered materials No. 507 - Improvements to High-resolution Precipitation Nowcasts
High-resolution Precipitation Nowcasts-, February 27, 2019

(3) Japan Meteorological Agency: Manual on Codes (in Japanese based on International Codes, Volume I.2, Annex II to the WMO Technical Regulations) 8, No. 23 March 1990 (revised December 12, 2018)

(4) Japan Meteorological Agency: Manual on Codes (in Japanese based on International Codes, Volume I.2, Annex II to the WMO Technical Regulations) Appendix No. 36, March 1997 (revised January 12, 2022)

[Contacts]

Pacific Consultants Co., Ltd. Digital Services Division, DX Promotion Division, Traffic System Office, 3-22 Kanda Nishiki-cho, Chiyoda-ku, Tokyo, 03-6777-4476,
Contact: Naohiro Uchiyama