5 Data Connection and Use to Achieve Society 5.0

(1) Promoting Data Connectivity

Building and Designing a Geographic Architecture (Overview)

Kotaro Matsumoto and Yasuyuki Koga (Cabinet Office)

Abstract: SIP-adus is involved in building the dynamic maps through generating and distributing the high-precision 3D maps required for automated driving and the traffic environment information linked to those 3D maps. This geographical data is anticipated to prove useful beyond automated driving and advanced driver assistance systems, in areas such as MaaS, support for evacuations during a disaster, and managing the flow of people and goods. As part of its efforts to realize Society 5.0, in which linking and using data across disciplines will be essential, SIP-adus is not only generating and distributing the traffic environment information used in automated driving, but also working to building a portal to that information that promotes the marketing of geographic data for the purpose of creating a data business market.

1 Background

The Society 5.0 we seek to achieve will offer a high-level fusion of the cyber and physical spaces. Thanks to innovation spurred by the use of big data and AI, this new society is expected to produce new business models, create new value in various fields and bring about a paradigm shift in socioeconomic systems. To create such innovation, it will be important to coordinate data in a manner that transcends the barriers between fields, rather than limiting it to a specific field as is the case now.

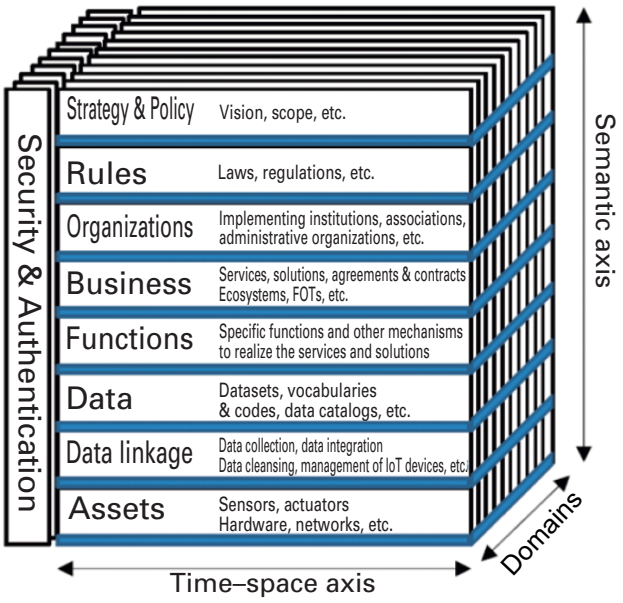

Fig. 1: Reference Architecture for Society 5.0

With that in mind, the Big-data and AI-enabled Cyberspace Technologies SIP project has, since 2019, been working on establishing both cross-field and field-specific data linkage infrastructures. At the same time, it has also been building and testing an architecture (called the Society 5.0 Reference Architecture) based on a framework designed to deepen the perspective and understanding of all parties involved to develop and standardize mutually linked and coordinated technology encompassing interoperability between infrastructures. Building the architecture has involved efforts to accelerate, notably, AI technology development, social implementation, cross-field coordination, and international standardization strategies in the context of smart cities, fields related to geographic information (automated driving, agriculture, disaster prevention, infrastructure), and fields related to personal matters.

2 Initiatives in SIP-adus

The SIP-adus program has worked on building an architecture for geographic data, and defined an automated driving architecture concerning that data (the Automated Driving Architecture) that draws upon the Society 5.0 Reference Architecture.

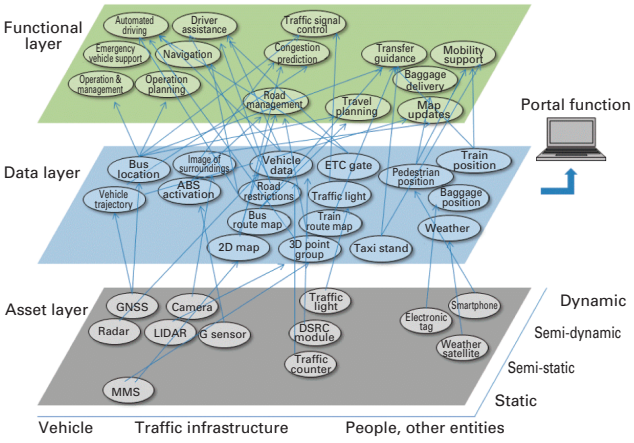

Fig. 2: Automated Driving Architecture

To make use of traffic environment information across multiple fields, the Automated Driving Architecture has been used as a basis

to (a) build a traffic environment information portal, (b) conduct field operational tests (FOTs) in the Tokyo waterfront area based on use cases in the logistics and mobility fields, (c) hold a contest for an application to solve traffic-related issues in the sightseeing city of Kyoto, and (d) develop a share operation management and reservation system that can be put to use in regional automated driving services.

Moreover, in 2020, example cases of the use of mobility-related data in and outside Japan were investigated and analyzed. The public and private sectors then collaborated on assessing the strategy, rules, and organizations upper layers of the Society 5.0 Reference Architecture in the context of the application of mobility-related data to establish an environment allowing the parties involved to use that data smoothly and appropriately. After getting input from data providers, service providers, information collectors and academic experts based on that assessment, discussions by a panel of specialists led to compiling proposed guidelines for the handling of data in the field of mobility, as well as public-private sector data linkage proposal.

2.1. Building and Launching the MD communet™ Traffic Environment Information Portal

In building the traffic environment information portal, we aimed to enable one-stop browsing by consolidating, visualizing, and cataloging the traffic environment information and other data layers to serve as a trigger for matching data providers and users. This was done while envisioning the functional layer services based on the Automated Driving Architecture. In addition to keywords, the portal also features advanced data searching functionality keyed to area and purpose, the use of machine learning to search for similar data, a suggestions function, and other functionality that matches seeds to needs.

The portal offers an open API enabling diverse users to apply traffic environment information to a variety of services. The first step was the development and launch of the MD communet™ portal site (www.adus-arch.com) in October 2020 to promote the flow of information and support the creation of new services. The next step aimed to expand the number of users, data providers in particular. In April 2021, the participation of 11 corporations and organizations was obtained, and the site was made publicly available.

The MD communet™ traffic environment information portal will continue to assess the requirements and mechanisms necessary to continue to disseminate traffic environment information for various uses. At the same time, social implementation will be pursued through efforts to broaden the deployment and enhance the functionality of the portal.

Fig. 3: Website for the Deployment of MD communet

2.2. Application Competition

Based on the creation and expansion of use cases that make use of traffic environment data and mobility-related data to solve issues concerning traffic, a competition for applications and ideas to solve tourism and traffic issues in the global sightseeing city of Kyoto (an app competition to solve issues related to tourism and traffic, commonly known as the Kyoto Raku Mobi Competition). To hold that competition, SIP-adus obtained the cooperation of the Kyoto Municipal Transportation Bureau and other operators, and compiled and provided data on bus and train stops and stations, routes, schedules, and fares, data on baggage checking in and delivery, as well as shops, in the transportation sector, predicted congested times at sightseeing facilities, information on sightseeing locations, an API for site guidance services, and statistical data on congestion.

The competition served to both enhance awareness of the traffic environment information portal and to improve it based on the feedback received from users who entered the competition.

2.3. Development of Support System for Regional Automated Driving Services

In preparing a social implementation of automated driving services for local regions, we first summarized the functions, data and assets of those services in sparsely populated areas of such regions and clearly identified common issues. We then developed a reservation and operation management system (e.g., management of vehicle location and position, safety monitoring via on-board and exterior cameras, reservation management, boarding and deboarding information management) featuring a shared interface easily usable by anyone, including the elderly. During the development, we conducted FOTs in coordination with SIP-adus initiatives on the social implementation of automated driving services in Kamikoani, Akita and Iinan, Shimane, and incorporated feedback from service providers and users to make functional and other improvements.

Even as we continue to offer an inexpensive and affordable system, we will pursue the commercialization of support services and systems encompassing the use of communication functions in the traffic environment information portal with an eye toward strengthening interregional cooperation.

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

Naoki Iso (NTT Data Corporation)

The traffic environment information consisting of the high-precision map data prepared for automated driving, as well as data collected form road traffic or vehicle probes, also offers promising uses in industries other than the automotive industry. It is therefore important to build a system that enables the safe distribution of such information in an easy to use format. The MD communet™ traffic environment information portal site that consolidates data from the mobility field and provides coordination with other fields was built and launched to realize that system. Our activities to expand the use of the site include raising awareness by attracting corporate members and conducting various promotions, as well as offering matching opportunities both offline and online, in an effort to make the operation of MD communet™ sustainable. In addition, we are validating example services effectively use combinations the traffic environment information that plays a key role in social implementation and information from other fields.

1 Building and Launching the MD communet™ Traffic Environment Information Portal Site

1.1. Value of Offering a Portal Site

Realizing a society with a higher quality of life for all by helping to address various social issues such as reducing traffic accidents and congestion, facilitating mobility for vulnerable road users, and improving the situation of insufficient driver numbers and high costs in the logistics and mobility service industries through the commercialization and propagation of automated driving has been set as the goal of this program. Accordingly, we believe that contributing to the commercialization of automated driving is called for to realize a safe and secure society, resolve social issues, and create new business value.

A venue for people, information and data to come together and generate various ideas and services, the MD communet™ traffic environment information portal site was built for the purpose of helping to achieve the goal of the program. In conjunction with centralizing the diverse traffic environment information in the mobility field scattered here and there, this portal site is designed to promote the application of data and the creation of new business by offering various communication forums for users.

Consequently, the development of the site broadly focused on implementing the two functions of catalog searching and business matching.

For example, development efforts emphasized functions such as having the site proactively offer suggestions to users for the catalog, and enabling users to register needs or seeds, and to communicate with one another.

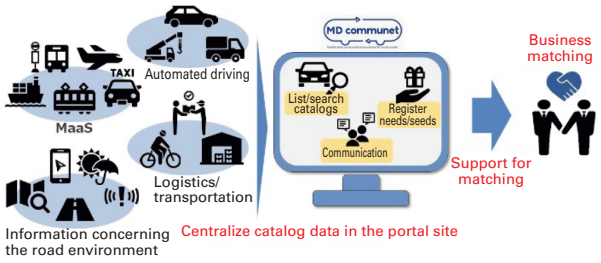

Fig. 1: Visualization of Business Creation via the Portal Site

As the site is expected to be used by people from various fields and professions, regular user feedback was incorporated in the development cycle to ensure due attention was given to UI and UX elements.

1.2. Functions Offered by the Portal Site

As stated above, the development of the portal site emphasized functions such as proactive searching and communication to promote business matching.

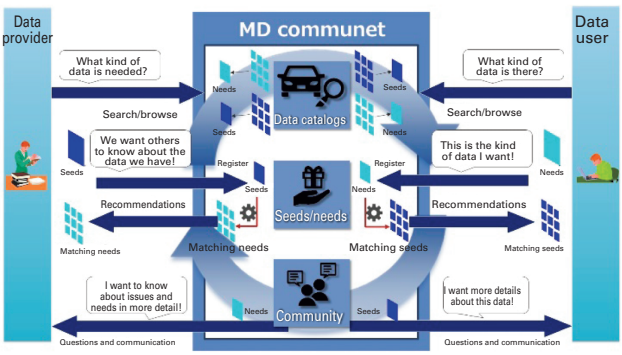

Fig. 2: Overall Picture of the Functions Provided by the Portal Site

The main functions offered by the portal site are described below.

(1)Data Catalog Search

This function not only implements and offers diverse search methods, but also enhances search accuracy to allow users to easily find the data they seek.

Available search methods range from basic functionality such as searching by data category or search through metadata or files for keywords entered by the user to searching for similar information based on the conceptual notions contained in the information, as well as a smart search feature involving the system automatically searching for information similar to the information entered by the user. The search methods are complemented by features designed to enhance the accuracy of searches. These include normalization of the text entered by the user (conversion between full- and half-width characters, upper- and lowercase, variant characters, and inconsistent transcriptions, as well as the removal of noise keywords in searches), displaying synonyms for search keywords, and keyword completion suggestions obtained from models generated by machine learning presented while the user is typing.

(2)Needs or Seeds Registration

This function visualizes the needs and seeds held by data providers and users, and assists with matching.

The system facilitates matching between users through an automatic search for catalog data recommendations adapted to the attributes o of the user when it finds matching information based not only on needs or seeds information registered by the user, but also on catalog data registered in the past and on information registered by other users.

(3)Communication

This function connects providers and users of data directly to foster the discovery of new data usages, as well as direct business matching.

More specifically, the system implements evaluation feature for the listed data, as well as a messaging feature allowing users to communicate with one another directly if they are interested in data or in needs/seeds.

1.3. Achievements in Preparation for Public Launch

Feedback from select early access members and participants in the Kyoto application contest was used in ongoing development to improve the match rate for user needs and seeds and enhance the convenience of the site when the site was launched in 2021.

One example is the building of a feature that periodically collects metadata from the data provider for some data catalogs, combines it with metadata in the portal, and rebuilds the catalog to update and offer the latest data on the site in real time whenever possible. We also developed additional functions such as text autocomplete and suggestions for metadata entered by the user to raise the accuracy of matching to enrich the functionality of the site.

The site also coordinates with existing data platforms such as the Geospatial Information Center and SIP4D. Linking of the data catalogs of other data platforms to our portal site at the system level both expands the categories of data and constitutes a cross-field initiative that encompasses geospatial information, disaster prevention, and other disciplines in addition to the automotive field.

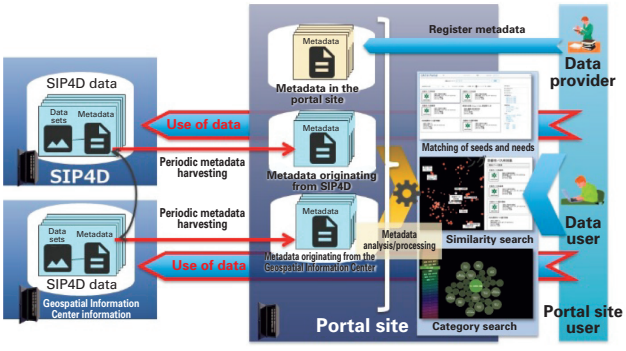

Fig. 3: Example of Additional Development to Offer a Rich Set of Functions
—Visualization of Periodic Metadata Harvesting—

At the same time, we are also coordinating development with marketing activities such as optimizing the system navigation from the landing page to the portal site.

1.4. Using the Portal Site as a Springboard for Business Matching

Since the launch of the portal in 2021, the growth in corporate membership and corresponding expansion of data catalogs has increase opportunities to match businesses, and the site is anticipated to play a vital role as a place where people and information come together.

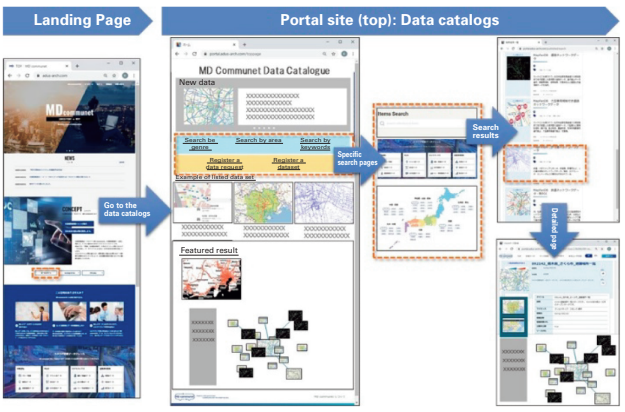

Fig. 4: Optimizing Navigation from the Landing Page

Our development policy will focus on features such as offering proactive suggestions and facilitating communication that establish the portal as a launch pad to promote business that makes use of data.

2 Initiatives to Raise Awareness of MD Communet™

2.1. Overview of Initiatives

Creating new services or value by spreading awareness and finding partners, as well as by encouraging the use of the data through matching, are important factors in ensuring the continued operation of MD communet™. Establishing partnerships involves more than finding partners who are on board with the MD communet™ initiative and can build it with us. It also means building an operational and promotional framework that enables smooth interaction between users. Encouraging the use of data is not limited to collecting a broad range of traffic environment information. It also requires generating opportunities for users to come across data they did not know about through the listing of distinctive data held by both the public and private sectors, and directing those opportunities toward the creation of new services or value. During the 2019 and 2020 fiscal years, we focused especially on finding partners, as well as expanding the listed data and raising awareness.

2.2. Finding MD communet™ Partners

Acting on our view that matching encompassing personal relations between players is both a major prerequisite and the most critical factor in the long-term operation of the portal, we have striven to find partners for this project. Using the objective and concept of this project as a basis, our first step was to summarize the vision we are pursuing and the value we offer and define the ecosystem we want to create through the project for the purpose of identifying the key draws of MD communet™, which are crucial to attracting partners.

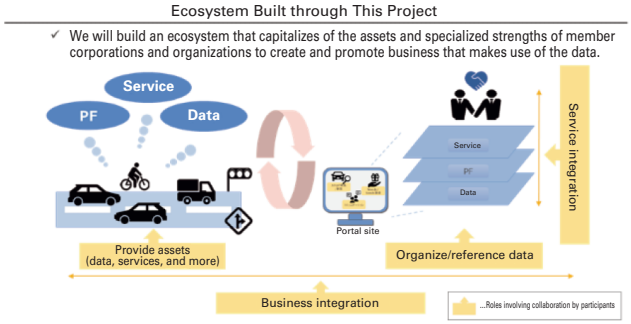

Fig. 5: Ecosystem Built through This Project

The next step was to survey and define the types of public and private sector stakeholders necessary to realize the ecosystem. We started by visualizing vehicles on the road and the flow of people, envisioning cases that make use that traffic environment information, and investigating the process of collecting and distributing that data. Next, w classified the applicable stakeholders as part of either the public or private sector. Public sector stakeholders are expected to consist of organizations affiliated with public offices or public interest incorporated association that owns, or has jurisdiction over, traffic environment information. Private sector stakeholders are expected to consist of business operators offering telematics services or other service providers. We summarized the relationships between those stakeholders and selected candidate business operators.

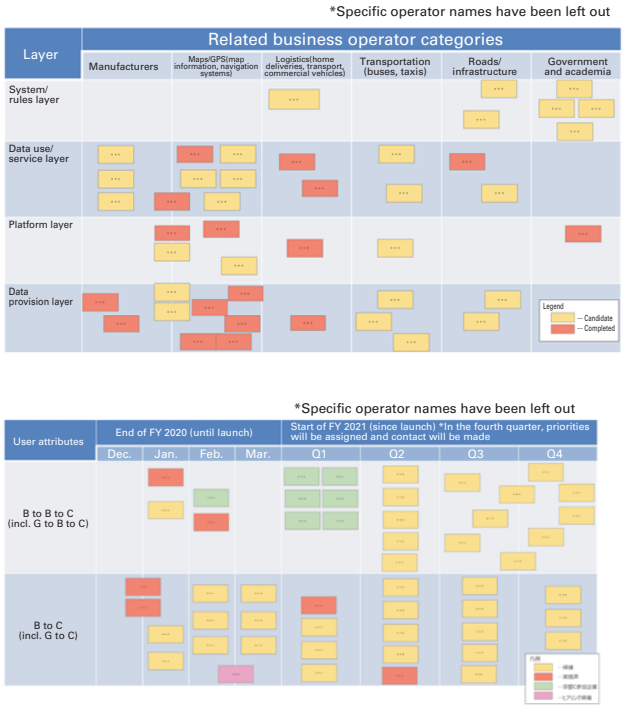

Fig. 5: Matching of Candidate Business Operators

During the 2019 fiscal year, we interviewed matching candidate business operators to gauge their interest and affinity with the vision pursued by the portal contents of the services, determine how interested and likely the company was to pursue business leveraging the portal, and understand their expectations concerning site functions and the data made available. The aim was to use their answers to refine our marketing activities and the functions of the site. The interviews provided us with hints about future portal function development and marketing activities for the operation and other aspects of the site, which were not only applied to its development, but also defined as issues to examine in the following fiscal year. For the 2020 fiscal year, we considered it important to consolidate traffic environment information from various corporations and list it as catalog data. We therefore approached business operators representing candidate data providers. We were able to welcome nine companies and two organizations as members who are in accord with the MD communet™ initiatives.

Thanks to the catalogs provided by participating companies, we have acquired over 5,000 catalog data items. We also expect to obtain vehicle probe and other advanced data by continuing to approach business operators.

Fig. 6: List of MD communet™ Corporate Participants

2.3. Awareness Raising Activities

In preparation for the launch of the portal site, we spent 2020 actively preparing content and conducting promotional activities to spread awareness of, and draw interest in MD communet™.

In addition to introducing candidate MD communet™ business operators in conjunction with the release of information in October 2020, we create and launched a landing page to obtain broad awareness and attract interest in the course of subsequent propagation and promotion. The landing page is intended to enable visitors to learn about the value and functions of the portal site, and encourage them to become members. As the entry point to the data catalogs, it therefore offers a broad range of information including an overview of available services, details on the listed catalogs, use cases, a description of the support provided, and instructions for becoming a member. It is designed to generate understanding and interest, and guide visitors toward registering as members or contacting us. As part of the design, we strove to plan and create a UI layout that is not troublesome to navigate for both people familiar with MD communet™ and those who are not. After the launch, we issued press releases and worked with SIP-adus related websites to raise awareness, while also making use of the landing page as a tool to introduce the portal as part of marketing activities.

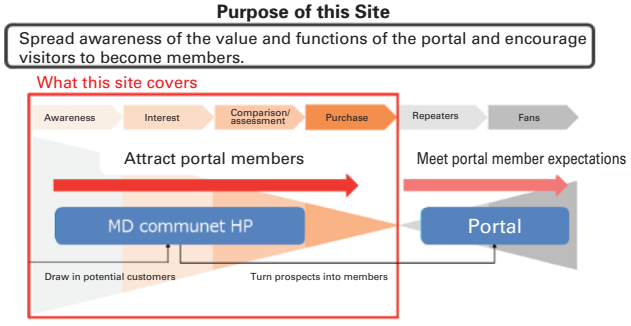

Fig. 7: Purpose of the Landing Page

Our next step was to produce a promotion video to foster understanding of MD communet™. In addition to playing it at various events, we launched the SIP café website to draw interest and guide visitors toward the landing page. Traffic directed to the site by SIP café increased, contributing to greater awareness.

Activities aimed at raising awareness of MD communet™ were not limited to the above content creation, and also included organizing an event. To spread awareness of MD communet™ and promote the potential offered by the use of mobility data, we held an event that relied on generating ideas in semi-closed environment to have participants rediscover the value of mobility data, experience methods for coming up with ideas, and meet potential future partner companies. On the day of the event, thanks to the cooperation of the Keio University Graduate School of System Design and

Management, corporations broadly involved in the mobile industry were able to present various ideas through lectures and workshops. The event also led to interaction between companies and highlighted the potential of matching companies through events.

Expand your business with the MD communet™ traffic environment information portal.
2021/1/18

Fig. 8: SIP-Café Press Release

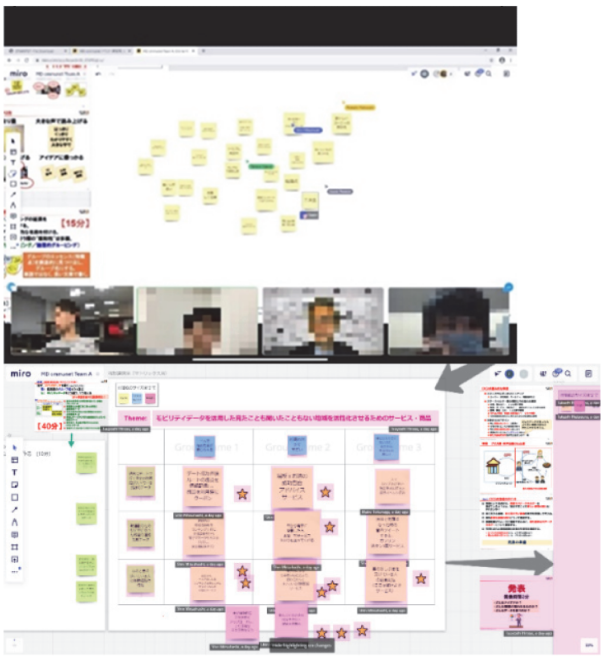

Fig. 9: Glimpses of the Day of the Event

2.4. April 2021 Public Launch and Policy for Subsequent Activities

The portal site was publicly launched in April 2021. The public launch was accompanied by press releases published in various media. We received inquiries and requests to join from many companies. We will continue to focus on finding partners who promote the use of the portal to make the site even more active. At the same time, we intend to mark this public launch by following through on our activity policy. To promote the creation of new data-driven business, we will carry out the activities in that policy to take both a virtual and real world approach to issues and matters of interest of data users and help achieve the creation of services. In specific terms, we will direct our efforts at matching companies and offer both virtual and real world support such as creating opportunities for companies to meet one another at events or producing content enabling online matching between companies.

3 Promoting Test Projects

3.1. Overview

The outcomes of projects in the first phase of SIP identified social issues pertaining to the fields of services for logistics operators as well as end-to-end multimodal navigation services. In 2019, using the geographical data architecture for automated driving (the Automated Driving Architecture), we selected use cases aimed at solving those issues, and conducted field operational tests (FOTs). The tests demonstrated the feasibility of producing new services with added value through the mutual provision of data between users.

In 2020, this was further followed up by identifying candidate data applicable to cooperative areas concerning logistics operator initiatives and issues based on surveys of problems faced by the logistics industry. This provided the groundwork for applying and coordinating of cooperative data that can help solve shared cross-industry social issues in the field of logistics.

Building on discussions with teams tasked with the investigation and test projects for more efficient logistics based on an architecture that makes use of SIP probe and other vehicle data, we also visualized services that capitalize on the portal while taking the above issues concerning the usefulness and provision of candidate data, as well as the approach to solving those issues, into account.

3.2. Initiatives in Fiscal 2019

We used the outcomes of projects in the first phase of SIP identified social issues pertaining to the fields of services for logistics operators as well as end-to-end multimodal navigation services to select use cases aimed at solving those issues, and conducted field operational tests (FOTs).

Turning to social issues, we chose offering truck drivers a safe and secure driving environment that encompasses the need to avoid dangerous routes when safe driving is considered for the field of services for logistics operators. With respect to end-to-end multimodal navigation services, we chose support for stress-free mobility that combines customized means of transportation (including automated driving) that covers means of transportation and route guidance matched to user attributes and adapts as needed to changes in weather, congestions, and other conditions.

In the field of services for logistics operators, our objective was to validate the extent to which value such a safe and secure environment or an improved work environment can be offered when the traffic-related information portal is used to draw upon data users did not know about or ways of using data they had not thought of. In line with that objective, we demonstrated applications that cooperatively provide geographical data from traffic-related information between users and make use of that information. We also interviewed truck drivers, operation managers with truck driving experience, and traffic information service providers.

In the field of end-to-end multimodal navigation services, our objective was to validate whether offering dynamic information achieves better support for stress-free mobility that combines customized means of transportation than in the past when the traffic-related information portal is used to draw upon data users did not know about or ways of using data they had not thought of. To achieve that objective, we defined FOT scenarios incorporating several use cases, and asked test participants to evaluate the functionality and point out flaws in a service application implementing all use cases.

	Use case	Details of test and evaluation
1	A. Receiving dock (location, whether there is wait time), route guidance that factors legally mandated breaks	• Test that providing route guidance that covers information on receiving docks (location, whether there is wait time) established as logistics cooperative areas or on rest locations contributes to improving working conditions.
2	A. Route avoidance based on road information (width/height) B. Alerts based on traffic signs	• Test that providing route guidance that relies on road information (width/height) generated by high-precision 3D maps to avoid vehicle width or height restrictions contributes to the safety and security of the driver. • Test that emitting driving alerts relying on traffic signs generated by high-precision 3D maps contributes to the safety and security of the driver.
3	A. Route avoidance and alerts making use of actual traffic information B. Gathering/use of actual traffic information through data circulation	• Test that avoiding roads with no actual traffic track record and emitting alerts while driving contribute to the safety and security of the driver. • Test that gathering actual traffic information by truck size from probe data, and using that information through data circulation, is possible.
4	A. Avoidance of dangerous roads or areas in the event of a disaster B. Sharing of information through collaboration with other fields	• Test that providing route guidance that avoids dangerous roads or entire areas in accordance with the extent of damages caused by a disaster contributes to the safety and security of the driver. • Validate methods of coordinating with data platforms form other fields (SIP4D) based on factors such as the retrieval of disaster information or gathered actual traffic information.

Fig. 10: Overview of Test for the Field of Services for Logistics Operators

	Use case	Details of test and evaluation
1	A. Receiving dock (location, whether there is wait time), route guidance that factors legally mandated breaks	• Test that providing route guidance that covers information on receiving docks (location, whether there is wait time) established as logistics cooperative areas or on rest locations contributes to improving working conditions.
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Fig. 11: Overview of Test for End-to-End Multimodal Navigation Services Field

For the two tests above, we built general-purpose APIs for providing and using data. In the semi-closed domain, we also implemented data circulation functionality to induce the autonomous growth of data in the cooperative area.

Moreover, we developed systems and applications built on the system configuration from the above FOTs, and enlisted the help of end users to test the use cases and validate the key evaluation points.

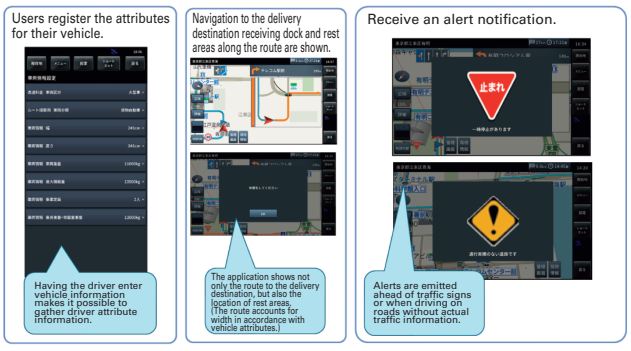

Fig. 12: Field of Services for Logistics Operators

The FOT results demonstrated that, with respect to services for logistics operators, route guidance accounting for static information such as receiving docks or rest areas, road information, traffic signs, particularly for unfamiliar routes or road environments that have changed helped in offering a safe and secure driving environment for truck drivers. At the same time, in terms of the usefulness and scope of data in cooperative areas, public-oriented usage was shown to be a useful cooperative area. In addition, some cases made it clear that sharing could provide tremendous benefit depending on the characteristics of the data.

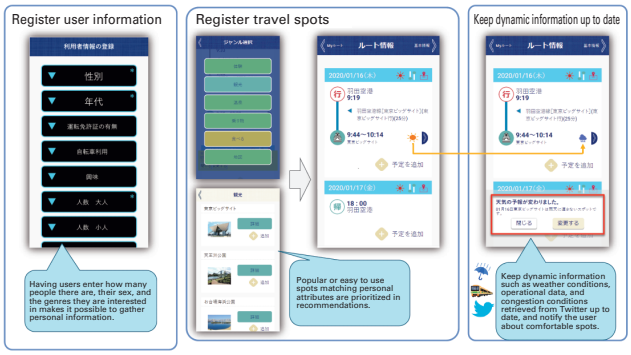

Fig. 13: End-to-End Multimodal Navigation Services Field

For the end-to-end multimodal navigation services, we implemented functions covering means of transportation and route guidance that factor user attributes and adapt as needed to changes in weather, congestion, and other dynamic information. In addition, information such as actual behavior or duration of stay collected by the application could prove useful for marketing or other purposes, and therefore points to the potential of applying cooperative area data flowing through the portal to other fields.

3.3. Initiatives in Fiscal 2020

We tested our hypothesis on data applicable to cooperative areas by employing the specific data generated in the logistics industry to identify issues concerning the candidate data that can help solve shared cross-industry social issues in preparation for making cooperative area data available for use in the portal.

We started by examining the types, specifications, and other parameters of the candidate data covered by the SIP logistics streamlining test to identify the potential for generating and providing candidate cooperative area data from the field logistics that can also be capitalized upon by other fields.

In preparation for generating candidate cooperative area data, the 2019 interview with logistics operators, guidelines for logistics systems, and logistics operators corporate social responsibility material were used to find initiatives and keywords deemed useful and extract data anticipated to be needed in the field of logistics.

The extracted data formed the basis for defining and assessing use cases addressing issues related to the flow of data that converts vehicle information viewed as candidate data in terms of SIP logistics streamlining into assets, and to the use of data extracted from those assets.

The data use cases studied in various fields (logistics, local governments, construction, navigation systems, automobiles, infrastructure) up to the previous year were used to select use cases with potential cross-field use in the context of tasks relying on vehicles.

After selecting the use cases, we used the list of data items in the data currently retrieved from vehicles document shared by the SIP logistics streamlining operators to examine how useful and worthwhile the data from previously studied use cases is. Working from the Society 5.0 Reference Architecture, we envisioned issues from

No.	Name of use case	Overview
1	Generate rest area information	Coordinate the GPS from the digital tachometer and spot information to identify rest areas available to the truck.
2	Generate actual traffic information	Coordinate the vehicle GPS system and direction of travel with road link information to identify actual traffic by vehicle type.
3	Generate receiving dock information	Coordinate the GPS from the digital tachometer with spot and road information to identify (destination) receiving docks in the area.

Fig. 14: Defined Use Cases

a rules, business, and technical standpoint, assessed initiative proposals, and held discussions with SIP logistics streamlining operators to enhance the worth of the data. The discussions brought out new business and technical issues.

Moreover, the issues identified for the application of data to cooperative areas and the approach to solving those issues formed the foundation of our study to visualize the creation of a truck industry parking lot sharing service that makes use of real time free parking space information.

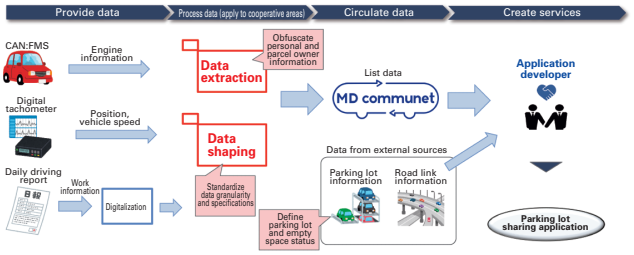

Fig. 15: Visualization of Service Creation Oriented toward Problem Solving

3.4. Future Initiatives

In 2020, we assessed use cases for the coordination of data applicable to cooperative areas with other fields, verified and summarized the usefulness and worth of that data, and examined both the flow of data provision and technical processing specifications. This was followed by a study to visualize the creation of services making use of MD communet™. Starting in 2021, we will consolidate the issues involved in realizing the service creation visualized until now, assess various specifications, and propose detailed service creation plans to bring about the actual creation of services from data listed in MD communet™.

Resolving Social Issues in Cities Popular with Tourists

Noriyuki Hayashi (Mitsubishi Research Institute, Inc.)

A competition for applications and ideas to resolve social issues related to tourism and traffic in Kyoto, a city popular with tourists from around the world, was held based on the concept of identifying use cases that utilize road traffic environment data to help resolve issues concerning traffic in urban areas (an app competition to resolve issues related to tourism and traffic called the KYOTO Raku Mobi Competition). Before holding the competition, the cooperation of the Kyoto Municipal Transportation Bureau and other business operators involved in traffic, logistics, and tourism was obtained in the compilation and provision of data on mass transit bus stops and train stations, routes, schedules, fares, baggage checking in and delivery services, and shops, information on facilities and sightseeing locations in the tourism sector, statistical data about past congestion, as well as future predictions for congestion, map application programming interfaces (APIs), and so on. The competition served to enhance awareness of the traffic environment information portal site, while collecting and utilizing data posted on the portal site through collaboration and consultation with various relevant parties.

1 From the Planning and Preparation Phases to the Competition Launch (Initiatives in Fiscal Year 2019)

Envisioning a range of use cases that might help to resolve issues related to the movement of people and logistics in urban areas, this project studied the idea of planning an app competition to help achieve this objective using road traffic environment data (such as data related to traffic, logistics, and facilities) focusing on Kyoto, a city that is faced with various issues, particularly related to tourism and traffic.

A wide range of use cases were studied targeting various key attributes (residents, tourists, government, transportation providers, and so on) as services related to mobility and logistics in urban areas. Specific examples of use cases related to tourists include the following: (1) provision of tourist route guidance that avoids lines of movement used by local residents, (2) recommendation of so-called "hands-free tourism" by enabling tourists to check in their baggage, (3) proposal of destinations factoring in predicted congestion, and (4) information services factoring in congestion and the operational status of transportation services.

The provision of tourist route guidance that avoids lines of movement used by local residents was studied because over-concentration of tourists on public transportation (normal buses and the like) heading to some popular sightseeing locations can cause congestion on the lines of movement used by both tourists and local residents.

The recommendation of hands-free tourism by enabling tourists to check in their baggage was studied because tourists tend to carry large bags onto buses, causing buses to become crowded. This use case envisions changing the attitude of tourists from carrying bags around to checking in their baggage and travelling light.

The proposal of destinations factoring in predicted congestion was studied due to the conspicuous over-tourism that occurs when tourists become concentrated in one area.

Finally, information services factoring in congestion and the operational status of transportation services was studied because tourists often comment that public transportation is crowded, route buses are particularly difficult to use, and that it is easy to make mistakes when changing from one service to another. Since the provision of transportation information seems to be an issue, services that consider the congestion and the operational status of transportation were envisioned.

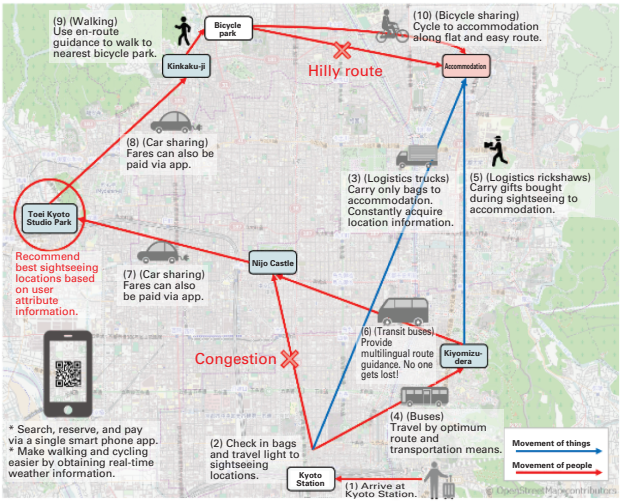

Fig. 1: Examples of Studied Use Cases (Tourist-Focused)

By studying these use cases, various items of data that might be useful for resolving issues related to mobility and logistics in the popular sightseeing city of Kyoto were identified and classified into the following three categories: traffic, logistics, and facilities. After explaining the premise of the project, the necessary data was then requested and procured from the relevant parties.

It should be noted that the data related to public transportation was prepared and provided as far as possible in the standard GTFS-JP format. This was carried out from the standpoints of data standardization, the utilization of route selection services, and so on.

Based on these studies, an app competition was planned to identify applications and ideas for helping to resolve tourism and traffic issues in Kyoto. The competition was then held from February, 2020.

A press release was issued on February 14, 2020 and the competition side was unveiled on February 25 of the same year.

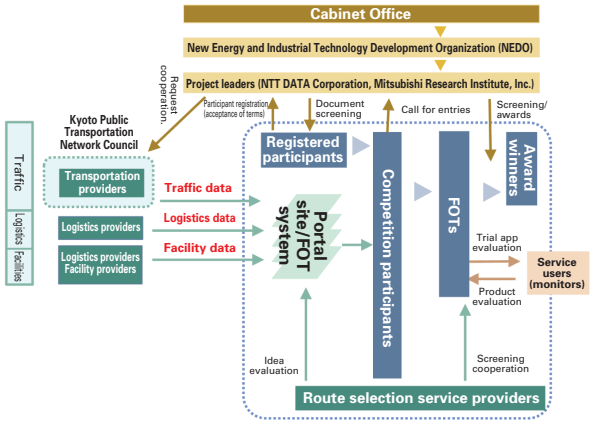

Fig. 2: Implementation Scheme of App Competition

Fig. 3: Unveiled Competition Website (Announcement Page)
Source: KYOTO Raku Mobi Competition website (https://web.contest.adus-arch.com/)

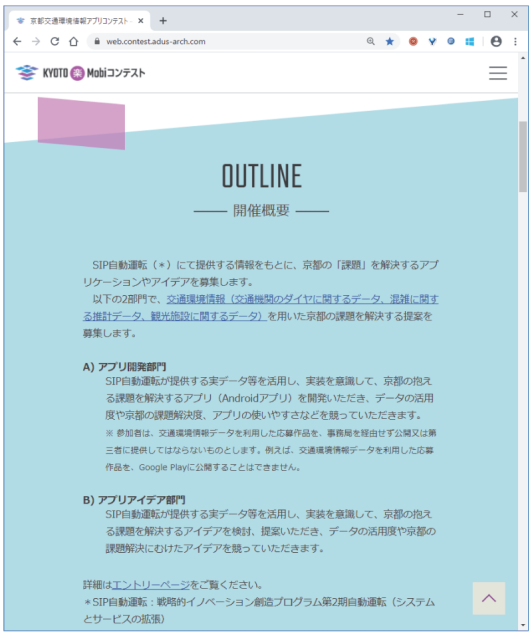

Fig. 4: Unveiled Competition Website (Outline of Competition)
Source: KYOTO Raku Mobi Competition website (https://web.contest.adus-arch.com/)

In fiscal year 2019, the data to be posted on the portal site through consultation with various relevant parties was collected, and an environment for providing road traffic environment information and data, an application programming interface (API), and the like was prepared. These initiatives enabled the launch of the app competition

2 From the Operation Phase to Screening and Award Giving (Initiatives in Fiscal Year 2020)

In fiscal year 2020, the KYOTO Raku Mobi Competition moved into the operation phase. In addition to providing participants with road traffic environment data and the API, explanations of the details, specifications, and the like of this data, lectures about issues related to traffic and tourism in Kyoto, information exchanges, and mentoring of individual competition participants were also carried out.

The KYOTO Raku Mobi Competition was divided into two categories: the app development category and the app idea category. The objective was to call for both app products and ideas to help resolve the issues of Kyoto using data related to traffic and facilities (road traffic environment data) provided by the competition administrator and by showing an awareness of social implementation.

In the app development category, participants were asked to use the actual data and API provided by the competition administrator to develop an Android app. This category was judged based on the degree that the app utilized the road traffic environment data, its effectiveness in resolving issues affecting Kyoto, the user-friendliness of the app, and so on.

In the app idea category, participants were asked to conceive and propose an app that references, analyzes, or otherwise utilizes the same actual data provided by the competition administrator. This category was judged based on the potential data utilization of the app, its potential for helping to resolve issues affecting Kyoto, and so on.

Entries were subjected to document screening, as well as field operational tests (FOTs) and evaluations by monitors that used the apps. After a final decision meeting on Saturday, October 17, 2020, an award ceremony was held on Saturday, November 7. A total of seven entries were selected and awarded prizes. The winner of the top prize in the app development category (the Pedestrian Friendly City Kyoto Prize) was an app provisionally called “Kyoto Tourism Assist,” which supports the movement of visitors to Kyoto using public transportation GTFS-JP data as well as other road traffic environment data. In addition, the winner of the top prize in the app idea category was an app called “Teburan, the app that makes you want to go for a stroll empty handed,” which aims to demonstrate and apply new value to the concept of walking around sightseeing locations without having to carry heavy bags.

Fig. 5: Award Ceremony

After the award ceremony, a meeting was held with the creators of the app that won the top prize in the app development category (the Pedestrian Friendly City Kyoto Prize) to request the development of a completed app with the aim of realizing social implementation. In this app, the GTFS-JP data supplied for app development is processed by analyzing and integrating GTFS-JP data in advance into JSON files, which are incorporated when the app is started up for the first time, creating a traffic information database in the Android terminal.

As a result, two versions of the app were developed. First, Kyoto Tourism Assist (Android Version) is a smart phone app that assists mobility and tourism in Kyoto. Its functions include (1) displaying map and environmental data, (2) displaying transportation routes and schedules, and (3) searching for sightseeing routes.

Fig. 6: Screens of the Kyoto Tourism Assist (Android Version) App

Second, Tourist Route Creation (Web Application Version) is a web application for registering and editing recommended routes to be used by the Android app.

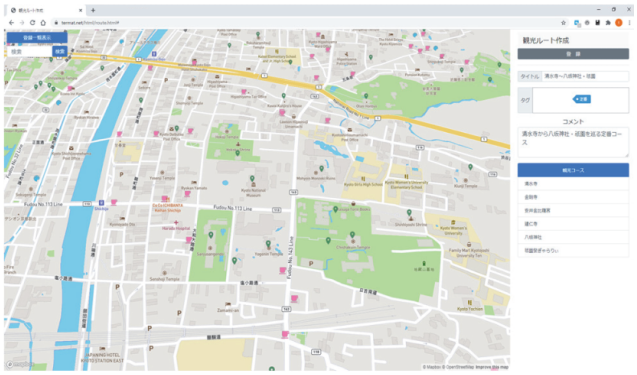

Fig. 7: Screen of the Tourist Route Creation (Web Application Version) App

In addition, the conditions and the like for continuing data provision were confirmed and discussed with the transportation providers and the like that supplied the data for the competition. First, individual negotiations were held with the providers of the data used by the winners of the top prize in the app development category. The contract to provide data for the purposes of the competition was extended until March 2021 (the duration of the contract of the project). As a result, it was possible to continue using the data for developing the prize-winning app.

The possibility of continuing the provision of data other than that used by the top prize winner in the app development category was also discussed. Many transportation providers felt that the provision of materials related to schedule data for the competition would not be an issue. However, in this case, it was also felt that data provision should be limited to the competition participants and that the competition administrator should take responsibility for the quality of information. Discussions also focused on cost and operational burdens. Transportation providers are currently separately considering compatibility with the GTFS-JP format. If a direction for this approach can be agreed upon, then the continuation of data provision and utilization, as well as collaboration for competitions and the like might be possible.

3 Future Developments

Over the 2019 and 2020 fiscal years, this project planned, prepared, launched, ran, judged, and awarded prizes for an app contest as an initiative aiming to realize social implementation of the app. In the future, to popularize and encourage use of the road traffic environment data portal site (MD Communet), a second competition is scheduled that will continue to focus on Kyoto. The purpose is to help create an ecosystem that can facilitate matching between the provision and utilization of data in certain ranges and to help realize social implementation of the results, as an example of an initiative to resolve regional issues using road traffic environment data. Based on this policy, the objective is to build on the results of the first competition and to encourage interchanges between participants, including local data providers, local authorities and other relevant parties, as well as the competition entrants, and to facilitate the involvement and the like of local organizations with an interest in the operation of the policy.

Preparation of Environment for Encouraging Utilization of Mobility-Related Data

Shintaro Shimizu, Koichiro Meguro, Yurie Toyama, and Satomi Aiko (Mitsubishi Research Institute, Inc.)
Seiichi Tanaka (MRI Research Associates, Inc.)

Although mobility-related data has various potential applications, issues include how the data is handled and the federation of data between stakeholders. For this reason, it is necessary to prepare an environment to facilitate the participation of stakeholders in data utilization. In this study and research project, first, the issues hampering greater data utilization were identified and analyzed. Then, based on these results, the appropriate approach for preparing rules to encourage data federation and utilization was considered. As the process for promoting and accelerating data federation, the analysis results indicated that beginning data utilization with public data and then gradually incorporating private data would be a potentially effective way of realizing full-scale federation of public and private data. This project also studied the risks of handling data extracted from the analysis results. Countermeasures were studied from the standpoints of the data handling methods and the matters that must be addressed by businesses. The study results were summarized in guidelines related to data handling in the mobility field (referred to below as the "data handling guidelines") and a proposal for public/private data federation in the mobility field (referred to below as the "public/private data federation proposal").

1 Background and Objective

The utilization of mobility-related data (principally data from connected vehicles) has the potential to provide a wide range of value, from enhancing the safety of individual vehicles to helping to resolve social issues such as controlling traffic flows and responding to natural disasters. However, in addition to issues related to personal information and other aspects of handling this data, the lack of rules for the federation of data between stakeholders means that smooth progress is not being made toward its social implementation.

Therefore, the aim of this project is to create links between the public and private sectors, and prepare an environment to facilitate the participation of the relevant stakeholders in data utilization.

2 Studies and Analysis of Issues for Encouraging Utilization of Mobility-Related Data

2.1. Use Case Definition and Subjects of Study

First, this project extracted cases of mobility-related data utilization from the results of SIP-adus research carried out in previous fiscal years, and redefined 23 use cases in 9 fields as use cases for this project. In addition, as subjects for study in this project, one case featuring the utilization of public and private data was selected for each service user category (commercial vehicles, ordinary vehicles, and pedestrians). This selection was made from the following standpoints.

- Based on the objective of the federation of public and private data, the case needed to feature the utilization of both public and private data.
- The case needed to utilize mobility data obtained from vehicles or pedestrians.
- After classifying the use cases by the data user into three categories (commercial vehicles*, ordinary vehicles, and pedestrians), the case with the largest amount of data utilization in any of these categories was selected.

* Here, "commercial vehicles" refers to logistics vehicles, construction vehicles, and any other type of vehicle used by a business and managed by a fleet manager.

(1) Commercial vehicle use case (utilization of information to help provide a safe and secure driving environment for truck drivers)

In this use case, route guidance in accordance with the vehicle size or re-routing guidance in the event of an accident or natural disaster was provided to drivers based on the collected data. The aim was to realize smooth driving and to help provide safety and security to truck drivers (Fig. 1).

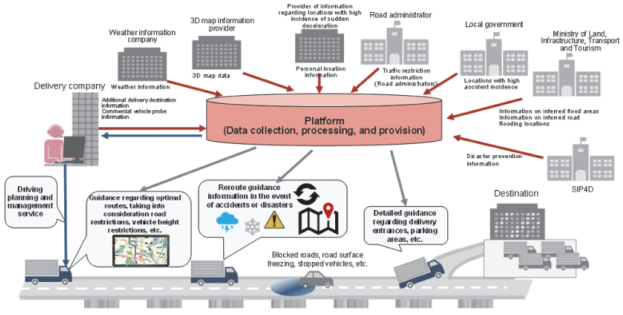

Fig. 1: High-Level Operational Concept of Commercial Vehicle Use Case

(2) Ordinary vehicle use case (provision of advanced information to vehicles (drivers))

In this use case, lane-level information was provided based on the collected data. Again, the aim was to support smooth driving by the provision of detailed information, and to realize safe and secure navigation (Fig. 2).

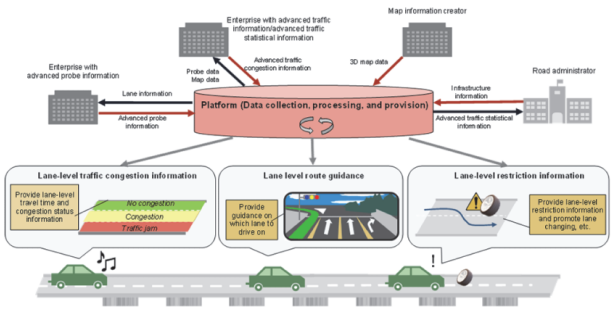

Fig. 2: High-Level Operational Concept of Ordinary Vehicle Use Case

(3) Pedestrian use case (information provision for easy-to-understand and smooth movement)

The aim was to provide route guidance in accordance with the attributes of the user and realize smooth movement based on the collected data (Fig. 3).

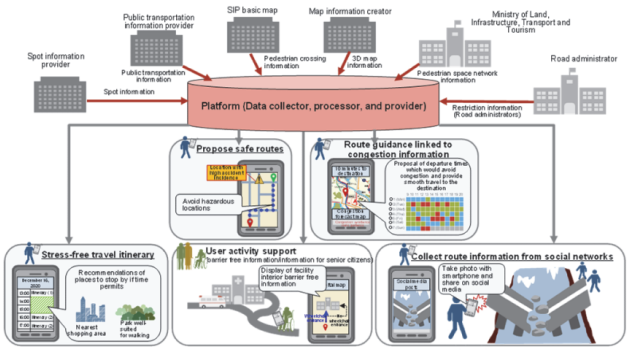

Fig. 3: High-Level Operational Concept of Pedestrian Use Case

2.2. Visualization of Use Cases with Reference Architecture

The three use cases described in the previous section were visualized using the Society 5.0 reference architecture, and the issues were analyzed. More specifically, the three use cases were applied to the DoDAF(1,2) architecture framework developed by the U.S. Department of Defense and visualized in each of the views defined by DoDAF. Figure 4 shows the relationship between the Society 5.0 reference architecture envisioned in this study and each view defined by DoDAF.

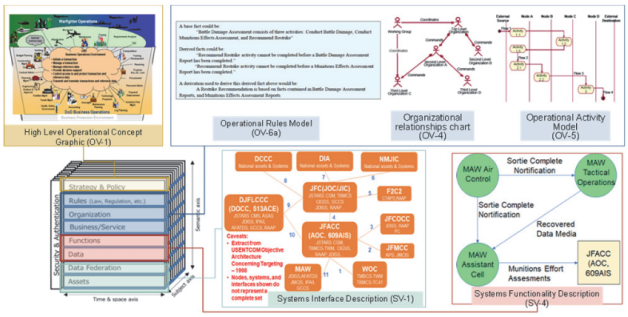

Fig. 4: Relationship between Society 5.0 Reference Architecture and Each View of DoDAF

In addition, the details analyzed using the architecture and the extracted issues were discussed with companies, organizations, and the like that actually handle mobility-related data. The validity of the analysis results were confirmed and the practical issues were identified.

3 Approach for the Federation of Public and Private Data

3.1. Role Allocation and Ideal Approach for Public-Private Data Federation

This project envisioned the following points as the objectives to be achieved by the federation of public and private data: (1) the acquisition of more data, (2) the operation of more seamless systems, and (3) the simple utilization of data. Therefore, the roles that must be carried out by public and private parties to realize the federation of public and private data were defined and summarized in the proposal document. In addition to defining the data held publically and privately, the roles for public and private parties and initiatives for realizing data federation were identified for use cases that generate value through the federation. Finally, the ideal approach for preparing the necessary rules was studied and proposed. Figure 5 illustrates these items.

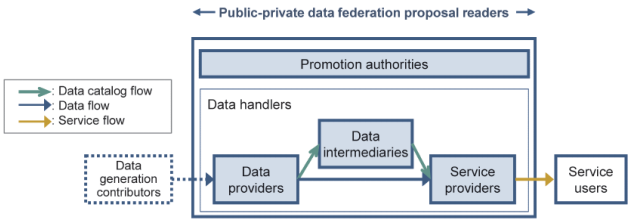

Fig. 5: Parties Envisioned in Public-Private Data Federation Proposal and Proposal Readers

3.2. Identification of Issues Related to Federation of Public-Private Data

When the relationship between the collated issues was analyzed, a negative spiral was identified in which the poor economic prospects of services using data and the impossibility of recovering the value of the service prompt data providers to restrict data distribution without ensuring that data is available in sufficient volumes or quality. A key point in promoting the federation of public and private data is to find ways of breaking out of this cycle and achieving economic feasibility from the standpoints of both data and service provision. Figure 6 summarizes the issues related to the federation of public and private data.

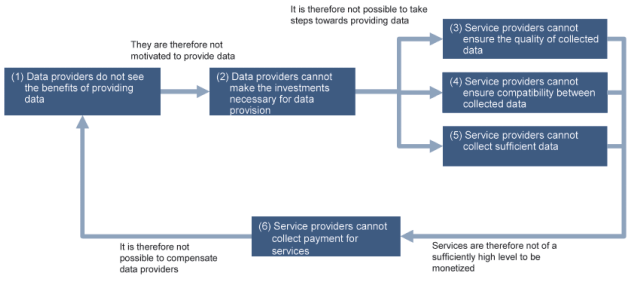

Fig. 6: Issues of Public-Private Data Federation

3.3. Procedure for Promoting Data Federation and Policy for Addressing Issues

Economic feasibility is a major hurdle toward the achievement of public-private data federation. This is a larger hurdle for private data than public data since the use of private data requires even more stringent judgments about economic feasibility. For this reason, the best way to realize full-scale public-private data federation is to start by utilizing public data and then gradually incorporate private data (Fig. 7).

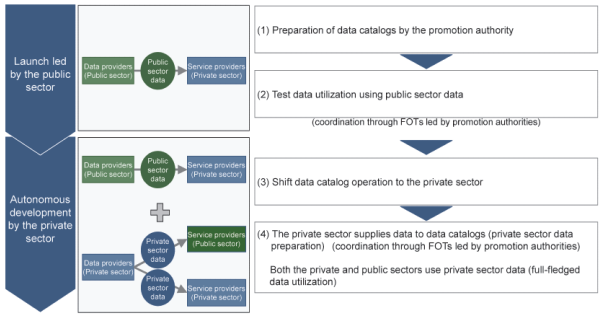

Fig. 7: Procedure for Promoting Data Federation and Policy for Addressing Issues

4 Data Handling Approach

4.1. Risks of Inappropriate Data Handling

The proper handling of data will encourage parties involved in data generation to provide data more confidently. Service users should also feel more confident about receiving these services. As a result, this should lead to the collection of more data and the provision of services with higher added value, further encouraging data utilization.

Consequently, to prevent the infringement of third party rights or other detrimental effects due to the improper handling of data, the data handling methods that must be followed by all parties were defined. In this project, the risks surrounding each type of data handled in the analyzed use cases were identified from the standpoints of the parties contributing to data generation due to the improper handling of data and the potential for infringing the rights of or adversely affecting service users.

4.2. Countermeasures for Risks

Approximately eight types of risks were defined related to data handling. Figure 8 shows the approach for responding to each of these risks. These countermeasures were described in more detail in the data handling guidelines.

Aggregated issues	Response approach
(1) Inappropriate collection of data leaving data generation contributors with an unfavorable impression	• Data providers provide explanations to data generation contributors and reach a consensus with them • In some cases, rules regarding data utilization rights are created with parties that contribute to data collection
(2) Inappropriate provision harming the business profitability of data generation contributors	• Data providers do not provide data to parties other than those agreed upon by data generation contributors, and data is not used for usage purposes other than those agreed upon
(3) Unintended data security issues making it impossible to guarantee service quality, leaving the data generation contributors with an unfavorable impression, or harming their business	• Parties that use data create and implement security management processes in accordance with appropriate security standards
(4) Inappropriate collection and provision of data violating rights protected by the Personal Information Protection Act	• Parties that handle data handle personal information in accordance with the Personal Information Protection Act • Alternatively, they appropriately anonymized personal information before using it
(5) Collecting and using data from various sources making it impossible to guarantee service quality	• Data providers and service providers use standardized formats and location referencing methods for data envisioned as being collected from various parties
(6) Inappropriate usage of data violating data copyright	• Copyrighted data is handled in accordance with copyright laws
(7) Data processing delays (reduced data freshness) detrimentally affecting service users, such as preventing them from traveling as planned	• Data providers and service providers confirm and agree in advance to matters such as the quality (accuracy, integrity, and validity), freshness, continuity, etc., of provided data
(8) Using data from sources whose reliability is unknown making it impossible to guarantee service quality	• Only in cases in which services do not require high quality data, service providers develop methods for using or improving the reliability of data whose reliability is unknown

Fig. 8: Approach for Issue Countermeasures

Two categories of risk countermeasures were described in the guidelines: data handling methods, and initiatives that industry should follow.

It should be noted that these data handling guidelines are not intended to restrict the parties involved, but as a reference model for handling data. In addition, since the parties involved in data handling and the handling environment are likely to change as data utilization progresses, it is assumed that these data handling guidelines will be updated on a continuous basis.

5 Conclusion

Visualization analysis of mobility data utilization identified a negative spiral in which the poor economic prospects of services using data and the impossibility of recovering the value of the service was leading data providers to restrict data distribution without ensuring that data is available in sufficient volumes or quality. To accelerate the utilization of data, it will probably be necessary to aim to realize full-scale public-private data federation by beginning data utilization with public data and then gradually incorporating private data. In addition, the appropriate handling of data should help to raise the confidence of both data providers and service users, which will facilitate the accumulation of more data and the provision of services with higher value, therefore further encouraging data utilization.

The data handling guidelines and proposal created in this project are intended as a reference model, and it is hoped that this model will help to promote data utilization in the future. Since the parties involved in data handling and the handling environment are likely to change as data utilization progresses, the proposal and data handling guidelines should be updated as necessary on a continuous basis.

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(1)DoD Architecture Framework Working Group, DoD Architecture Framework Version 1.0 Volume II: Product Descriptions, pp. 4-2, 4-28, 4-36, 4-47 (2004)
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