戦略的イノベーション創造プログラム

Cross-ministerial Strategic Innovation Promotion Program (SIP) Phase 2 /
Automated Driving for Universal Services /
Investigation and research for design and construction of architecture related to automated driving and driving support

FY 2020 Progress Report

Overview

Nippon Koei Co., Ltd.
PACIFIC CONSULTANTS CO., LTD.
Highway Industry Development Organization

March 2021

1.Project Overview

■Project:
Cross-ministerial Strategic Innovation Promotion Program (SIP) Phase 2 /
Automated Driving for Universal Services /
Investigation research for design and construction of architecture related to automated driving and driving support

■Trustee:
Nippon Koei Co., Ltd., PACIFIC CONSULTANTS CO., LTD.,
Highway Industry Development Organization

■Duration:
April 2019 – May 2021

■List:

1. Mapping reference architecture model to each layer and extracting target data
2. Summarizing the process of preparation and consensus building for the demonstration experiment
3. Summarizing the operation data specifications for self-driving vehicles
4. API and application requirements development
   1) Portal System(web) 2) Database
   3) Operation management system / Location system
   4) Reservation / user management system
5. Evaluation of services and apps in target areas
6. Summary of technical requirements
7. Consider / design and development of integrated system to support the introduction at the local
8. Discussions and service applications for social implementation of services
   (This year the target area: Kamikoani and Akagi kogen)

2.Steps of the Research Process

Research flow :

❶ Mapping reference architecture model to each layer and extracting target data

❷ Summarize the process of preparation and consensus building for the demonstration experiment

❸ Summarizing the operation data specifications for self-driving vehicles

❹ API and application requirements development

FY 2019

Portal System (Web) / Database / Operation management system / Location system / Reservation / user management system, and etc.

❺ Evaluation of services and apps in target areas

Verification of applicability through ongoing experiments

❻ Summary of technical requirements

Specifications and distribution tools to complete services

❼ Consider / design and development of integrated system to support the introduction at the local

❽ Discussions and service applications for social implementation of services
(This year the target area: Kamikoani and Akagi kogen)

FY 2020 Kamikoani, Akagi kogen

FY 2021 Okueigenji, Miyama

3. Basic Principles of Architecture (Mapping Reference Architecture Model to Each Layer and Extracting Target Data)

○The elements that make up the system (technology, individual systems, etc.), and the overall system structure (skeleton: framework) that expresses the relationship of the system.
○Essential for designing and developing a system to function as a system (System of Systems)
(*Some are quoted from MLIT HP)

Clarifying the position and composition of services, that are necessary for practical use. And organizing them with the purpose of popularization and generalization

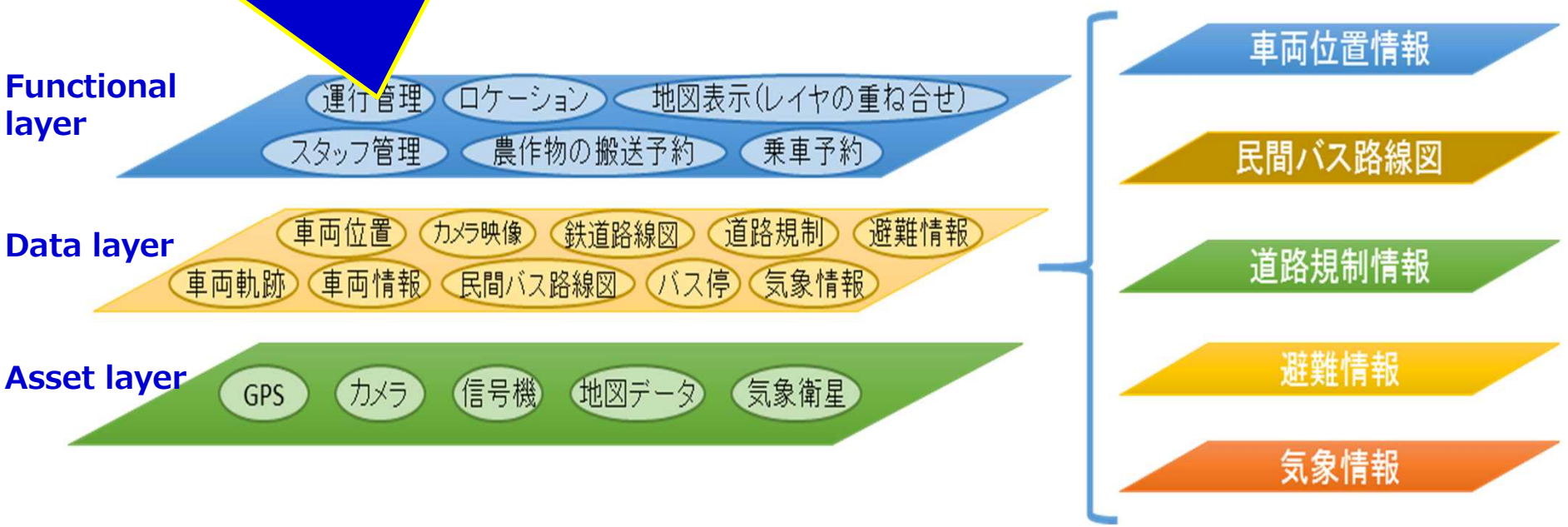


Image of Architecture

4. System Construction Policy (Mapping Reference Architecture Model to Each Layer and Extracting Target Data)

1) Building a nationwide system (database) that can share, and communize data formats and system configurations
2) Building a system (system) in which dynamic and static data are organically linked , and that links to each data

Consider System Architecture to Achieve This Policy

Construction policy

1) Information Items

・Items that include static and dynamic information. Static information are such as maps, facilities, operation schedules, etc. Dynamic information are such as boarding / alighting data (OD), weather information, disaster information, etc.

2) User Insight

・ Making of "travel plans" for users, and letting them know delays (delays in operation)

3) Behavior of a user

・ Introduction of information related to human movement (wandering of the elderly: watching service, etc.)

4) Communization

・ Based on GTFS, add data items for automated driving in rural areas to make them common

5) Sharing

・ Construction of a database assuming collaboration with other local governments and business entities

Social verification and system verification are achieved by long-term experiments

Construction of national standard version of management system architecture

5. Items For Each Layer (Stage Plan)

(Summary of Preparations and Consensus Building Process for Demonstration Experiments)

○ In this study, we will realize the functional layer of Stage1 that should be applied in rural areas.
○ Stages 2/3 are expected to be collaborative developments in the region and the private sector, depending on needs and issues in the future.

[Usage]
Blue : dynamic
Black : Static
yellow : correspondence /done

Functional layer

Stage1

Operation management:
・Location management (bus location)
・ Vehicle safety monitoring (video recording from inside and outside)
・ Vehicle dispatch management

Reservation Management :
・ Reservation for regular and demand flights
(Date, flights, user)
・ Function for travel planning

Boarding management (vehicle) :
・Management and browsing of boarding information

User function:
・ Authentication function (identity verification)
・ Vehicle reservation function
・ Browsing information such as bus location and timetable
・ Member non-member management (flat rate basis)

Stage2

Operation management:
・ Environmental information (weather, regulations)
・ Aggregation of usage results (aggregation of passenger data, sales, new registrants, operation information (suspension, delay, accident, etc.))
・ Display of outline map of operating route

Logistics management:
・ Transport items and delivery schedule management
・ Vehicle dispatch management

Facilities and equipment management:
・ Signals, road markings, signs, etc.
・ Electromagnetic induction line operation

User function:
・ Reservation function (local residents) related to facilities such as hospitals

Payment functions:
・ Fee confirmation / charge

Stage3

Extensions:
・ Watching over (the elderly wandering around, etc.)
Notification function to family
・ Dynamic timetable formation (AI, etc.)

Reservation management:
・ Travel planning service proposal function (AI, etc.)
・ Ability to share travel plans with your friends (SNS)

Facility equipment management:
・ Citizen contribution (voice of all)
・ Business / manager management

User function:
・ Reservation function in cooperation with tourist facilities
(tourist)

Payment functions (coordination with the market):
・ Transportation IC, CL payment, Point service

Data layer

D: Meaning of data

Operating route D, operating timetable D, stop position D, vehicle D

User D (date of birth, gender, etc.)

Operation D (camera, boarding history, balance D)

Map D, facility D, equipment D

Weather D, Regulation information D

Location information D (vehicle, stop, behavior of users)

Asset layer

Road space (lane, roadside, road installation, road equipment)

Business facilities (bus stop, charging facility, center, communication, satellite)

Self-driving vehicle

Vehicle accessories (cameras, etc.)

user

6. Results for FY2020

○This system was introduced in social implementation in Kamikoani Village from December 2019 and in long-term experiments in Akarai kogen from September 2020.
○The results of this year's project are shown below.

Classification	Findings / Results	Reference page
Improvement of functions based on issues	● In response to the findings and issues obtained in FY2019, **each function was improved and operated on a trial basis in each region**.	pp.7-11
Study / design and development of integrated system to support the introduction at the local	● In deploying the systems built in FY2019 to other regions, **we worked to consolidate (package) the systems that had been built individually and consolidate the equipment**. ● **Potential risks and solutions for introducing the system** to municipalities and communities in mountainous regions across Japan were examined.	pp.12-15
Discussions and service applications for social implementation of services	● Based on the usage and evaluation of each system in the regions where the installation and long-term experiments were conducted, **we studied solutions to improve functionality and further increase convenience.**	p.16

7. Improvement of Functions Based on Issues

○Verify the system for long-term experiments and social implementation, and identify issues for "practical use".

■Strict evaluation and expectations obtained through long-term demonstration

○During the operation of the long-term demonstration, we heard opinions from three parties (operation manager, driving assistant, and user) through experience
○Summarize their points of view
○Consider measures to address issues that need to be improved

Fig.1. The hearing opinions at Kamikoani

Fig.2. The hearing opinions at Akagi kogen

Classification	Findings / Results / Future tasks
Coexistence with other vehicles	・After operation starts, as time goes, other vehicles often did not slow down when it comes to passing the self-driving vehicle. → Advantage: The self-driving vehicle was publicized, and it was accepted to some extent. → Disadvantages: Concerns about reduced safety due to familiarity
Overall system	・For those who are unfamiliar with operating IT equipment (including elderly people), follow-up is required (large letters, easy input, etc.).
How to make a reservation	・Phone reservations are now more common than smartphone reservations. Therefore, reservation operators are needed.
Passenger	・When driven autonomously, it is important for crew members to make detailed calls to the vehicle such as turning to the left, stopping, starting, etc., for safe operation.
Operation management center	・It is important for the staff in the operation management center to understand the background, history, operation method, etc. of the automatic driving service in addition to operating the system so that they can respond appropriately to inquiries from local residents.
Displaying operating time etc.	・It is important to widely disseminate information related to operation (departure time: especially demand reservation) and current operation status in real time.
Level 4 introduction	・ For safety management, we have placed traffic guides and closed roads at the beginning and end of the Level 4 section. Along with this, there arises a problem that operating costs increase. ・ The Level 4 section was a farm road and was a passageway for field vehicles. Although there were no vehicles coming and going in the winter, but it became necessary to work on the fields in the early spring, which made it difficult to close the road for automated driving experiment.
Number of vehicles in operation	・ Kamikoani has three routes, which are operated by one vehicle. ・ It is difficult to reserve multiple simultaneous demands because one vehicle operates on three routes. The issue is the placement of multiple vehicles.
Operation management	・ In Kamikoani village, the temperature in winter became negative, and the application performance of the surveillance camera mounted on the vehicle was exceeded, so there was a problem that image cutoff occurred (a camera, that can withstand winter specifications and is inexpensive, is necessary).
Total system operation	・ A general contact for the architecture system is required so that staff at the operation management center who are unfamiliar with IT equipment can make inquiries.
Route	・ Since the route (bus stop) may be added after the operation starts depending on the needs of the residents, flexible system operation / improvement is necessary.

7. Improvement of Functions Based on Issues

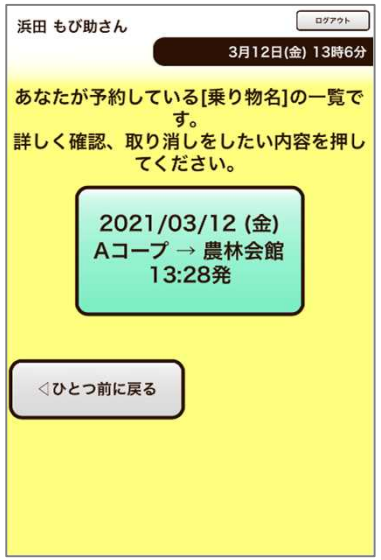
○Improving web design with usability in mind

For Administrators

Large size each operation button

For Users

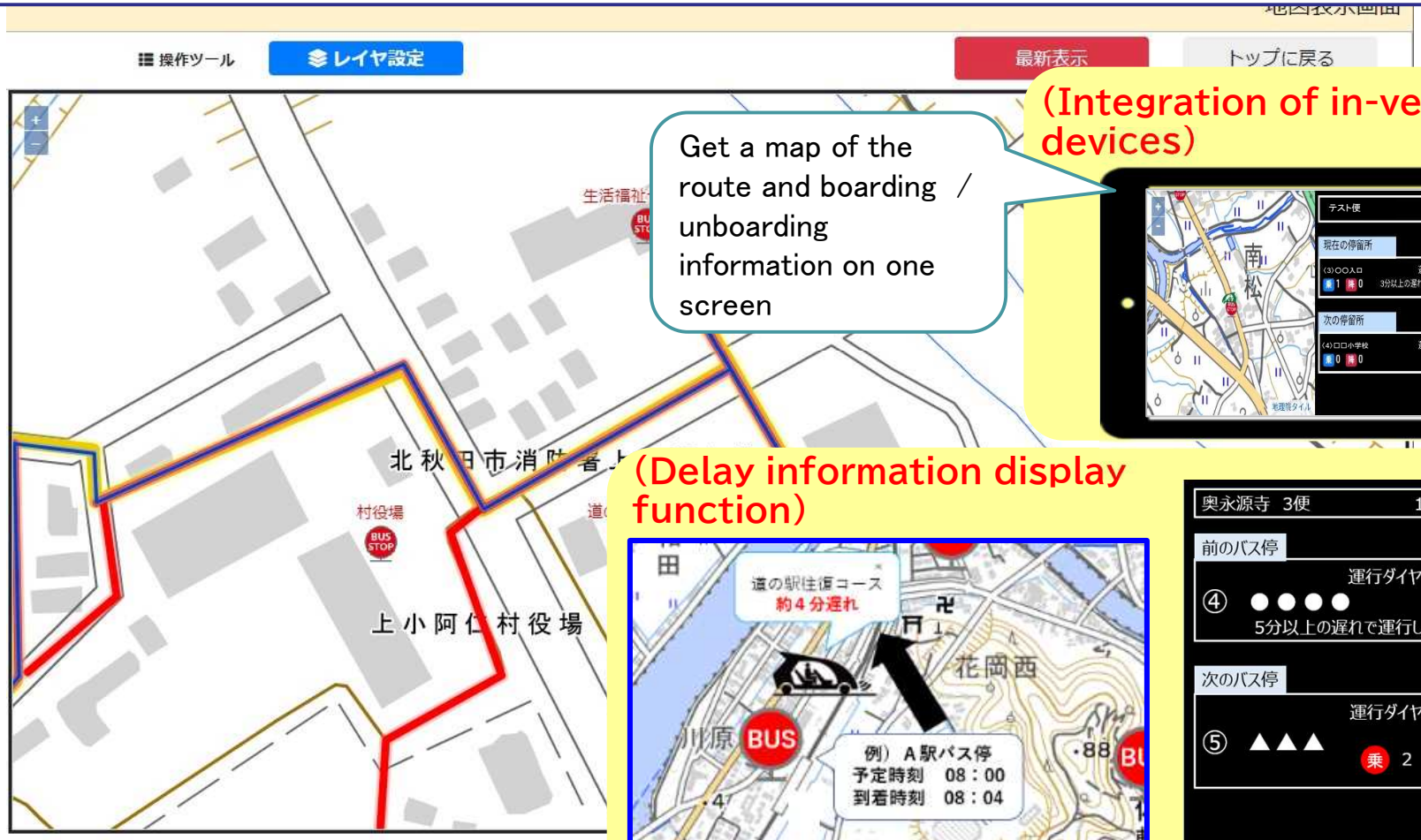
the letters large



7. Improvement of Functions Based on Issues

○Improvement of functions to support operation management / improvement of boarding and alighting management

1) Location (addition of delay information guidance function)
2) Vehicle safety (generalization of camera systems)
3) Integration of in-vehicle devices (easy to understand, consolidation of devices)



Get a map of the route and boarding / unboarding information on one screen

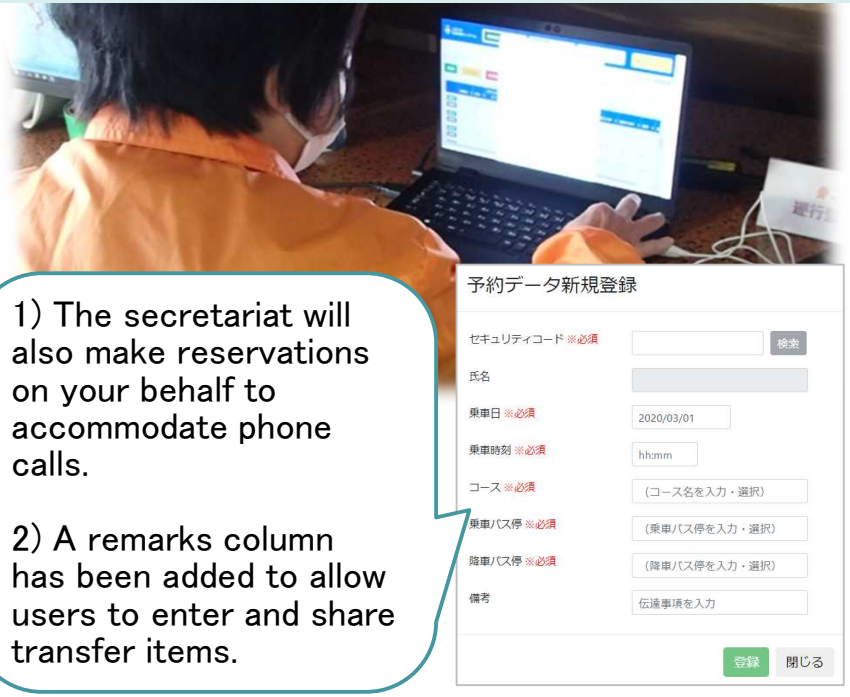
(Integration of in-vehicle devices)

(Delay information display function)

7. Improvement of Functions Based on Issues

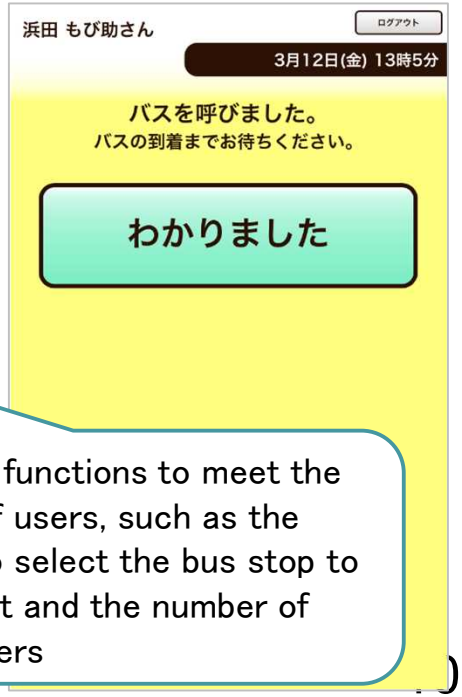
○Improved reservation function

1. Organize and handle diverse and complex reservation methods
   Two patterns(Travel plan / ride now)
   ↓ Struggling to meet the needs of many
   Many patterns(One-way and round-trip reservation, Number of passengers, etc.)
2. Administrator function to handle phone reservations (Easy-to-use input agent reservation function)



1) The secretariat will also make reservations on your behalf to accommodate phone calls.

2) A remarks column has been added to allow users to enter and share transfer items.



Improve functions to meet the needs of users, such as the ability to select the bus stop to get off at and the number of passengers

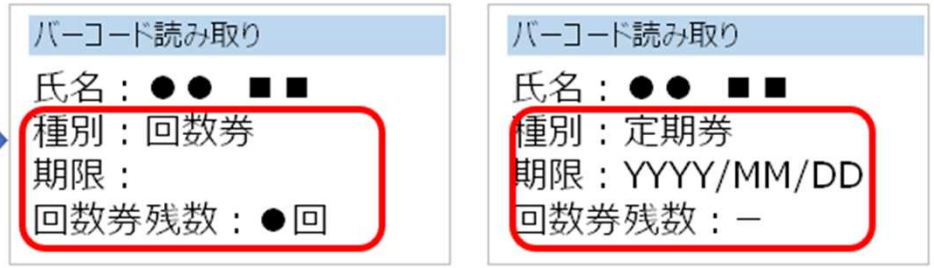
7. Improvement of Functions Based on Issues

○Improvement of user functions

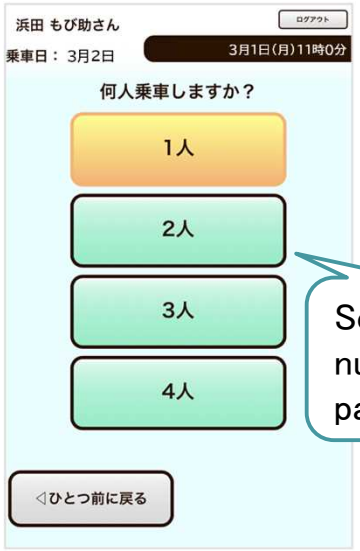
1. Support for subscribed forms of use (Coupon tickets)
2. Improving the user interface

- Coupon tickets and commuter tickets are also supported.
- Supports not only one-dimensional barcodes, but also QR codes

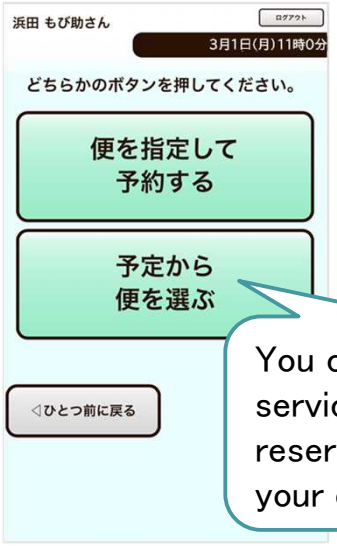
1. Different types of train ticket acceptable



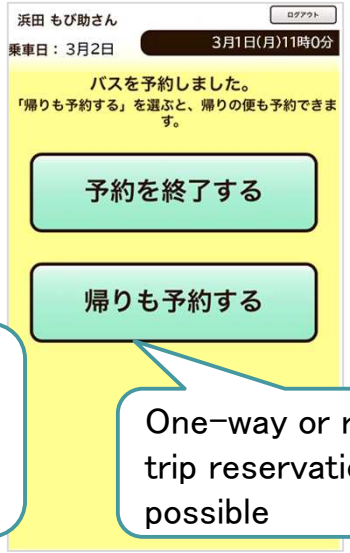
2. The user reservation system supports various patterns to meet the needs of users.



Select number of passengers



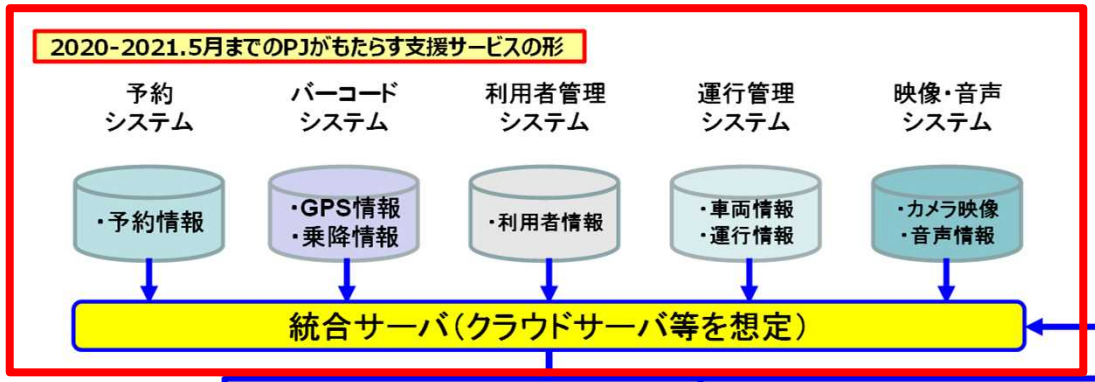
You can specify the bus service or make a reservation based on your own schedule.



One-way or round-trip reservations are possible

■Practice the second week of the PDCA cycle（Integration of development systems and implementation of functional improvements）

〇In order to achieve social implementation, we have consolidated (packaged) the systems that had been built individually.
〇System functionality has been improved to make it easier for service users (operation managers, drivers, and users) to use.
〇The system has been upgraded several times along with the development.



＋付加機能
Stage2,3の機能を暫時展開、外部サービスとの連携も想定
(例)
・見守り支援
・住民サービス
・ビッグデータ活用・・・

Consolidate functions and build an integrated server that can run independently

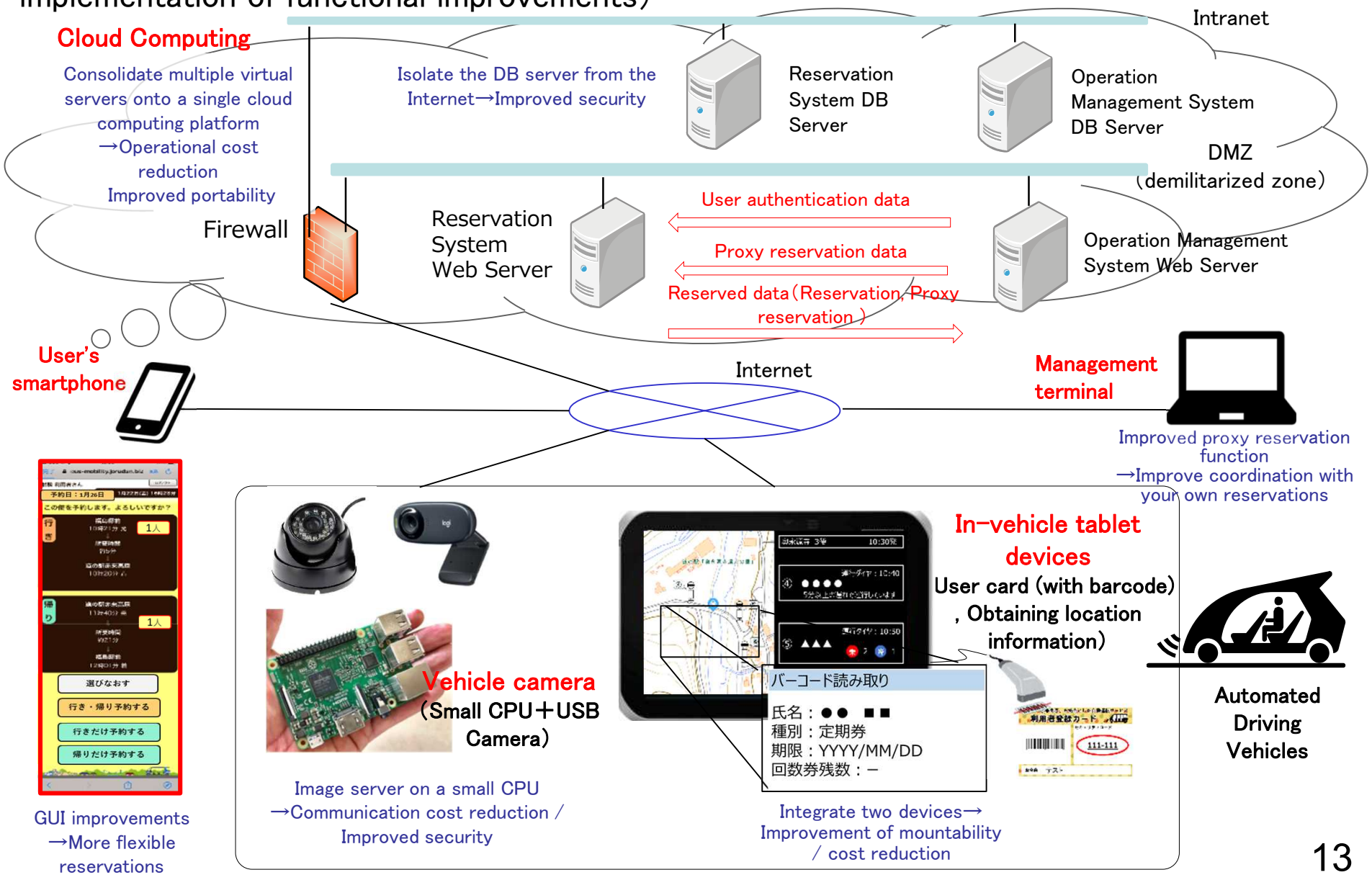
※However, some work is required to build the initial data. Information containing personal information, etc. needs to be managed.

Online management allows for uniform service throughout the country

※However, communication costs are necessary

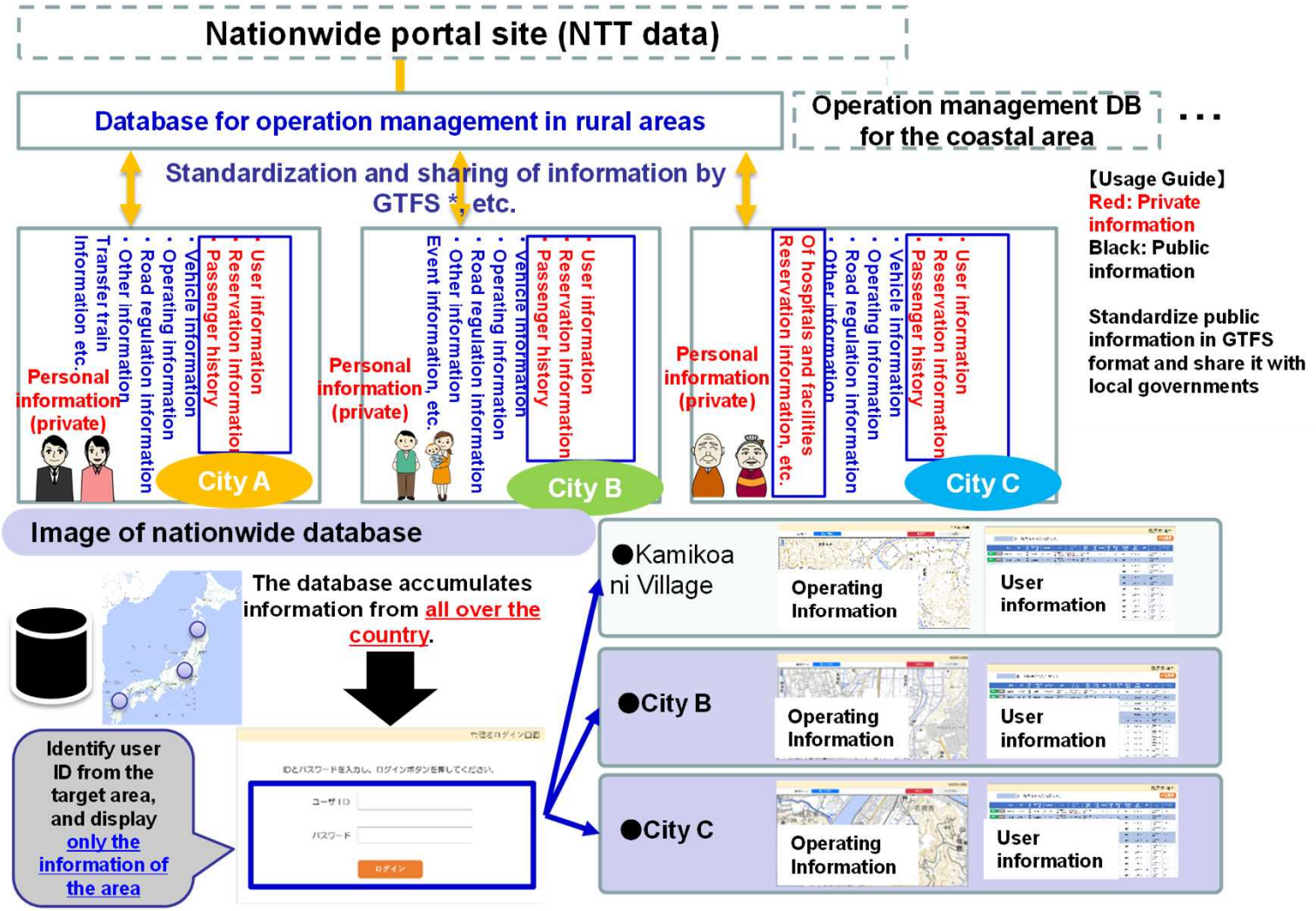
Streamlining and upgrading of in-vehicle equipment and improving operational efficiency

■Practice the second week of the PDCA cycle（Integration of development systems and implementation of functional improvements）



■ Integrated System → Design and development of the integrated system useful for deployment in rural areas

○Design a structure to support the operation of automated driving services in rural areas with a common service platform and database.



8. Consider / Design and Development of Integrated System to Support The Introduction at The Local

- The architecture system aims to be introduced to municipalities and communities in the mid-mountainous regions of Japan.
- On the other hand, since recent security incidents are becoming more diverse, complex, and sophisticated, we will consider the concept, policies, and measures for the security of this system as it is deployed nationwide.

◆Implemented software countermeasures based on "How to Create a Safe Web Site" by Information-technology Promotion Agency, Japan
◆Set the level of confidentiality and clarify the operation method for each level

【Current Issues in Security】
◆There are many issues and problems related to information security in the region where this system will be implemented.
◆Implement robust security measures if the operation is to be run by people in areas or age groups that are considered to have low information literacy.
◆The following are issues related to the definition of confidentiality levels and management methods in the mid-hills and mountainous regions based on the implementation and experiments conducted so far.

Confidential level	Definition	Management Method	Issues in mountainous regions
Level 4 【Top secret】	Important and confidential matters, with minimal supervision.	Encrypting the database *Administrator's password	— (For consortium staff only)
Level 3 【secret】	Information that could affect the Project, etc. if the information were to leak outside the scope of disclosure.	Isolate segments of the database For paper, store in a locked cabinet. *Personal information of users	・Items taken or left behind by staff with low information literacy ・Using the same password over and over again, or posting it on computers, etc.
Level 2 【confidential】	In principle, information available only to those with authority at the level of operation control center staff or higher. It is prohibited to leak the information outside the organization.	Available only to consortium staff and management staff who have been authenticated with a user ID and password ※Use of elder care services(If they know you're on board, they'll know you're not home.)	・In addition to the above, information leaks from small talk between residents
Level 1 【public】	Information disclosed to the public other than confidential information or information presumed to be a matter of public knowledge	Operation staff will store as appropriate	—

9. Discussions and Service Applications For Social Implementation of Services

■Status of use and planned use of the Architecture System

Kamikoani	Akagi kogen	Okueigenji	Miyama
【Usage Status】 Currently operating with the system updated in October 2020. The system was updated with a site visit in March 2020.  	【Schedule】 Long-term experiment ends in October 2020. Social implementation project in preparation (scheduled for this summer) 	【 Schedule 】 Social implementation project in preparation (scheduled for April) Started system development 	【 Schedule 】 Social implementation project in preparation (scheduled for this summer) System requirements are being reviewed (Operation timetable, operation method, etc.)
【Evaluation】 Reflecting feedback obtained through system training sessions and questionnaire surveys in the system ・Reservation for next day / Reservation for 2 or more seats ・Reservation by 3rd person ・Barcode scanning, etc. 	【Evaluation 】 The latest version of the system is under development with Akagi kogen (fixed route, on-time operation) as the basic form of the system.	【 Task 】 Obtain basic information such as route maps, bus stops, timetables, etc., and create GTFS →Need to understand the mobility needs of local residents and reflect them in the system	【 Task 】 Linkage with community buses, initial input work, etc.→Consideration should be given when content outside of the expected service arises.
【Remarks】 During the severe winter season (December onwards), there were continuous failures of in-car cameras and location-based phones.(Replaced and problem solved) →It is important to ensure reliability in severe natural environments such as heavy snowfall and freezing temperatures.	【Remarks】 Feedback on data preparation and functional improvement for social implementation	【Remarks】 System trial to begin in early April →Provide and improve local staff	【Remarks】 Building data for social implementation