戦略的イノベーション創造プログラム

The second phase of SIP- Automated Driving for Universal Services

Research on Model System for Improvement of Data Accuracy of Traffic Regulation Information

Progress Report 2021-2022

Summary

Japan Road Traffic Information Center
TOSCO Corporation
Dawn Corporation

2023 February

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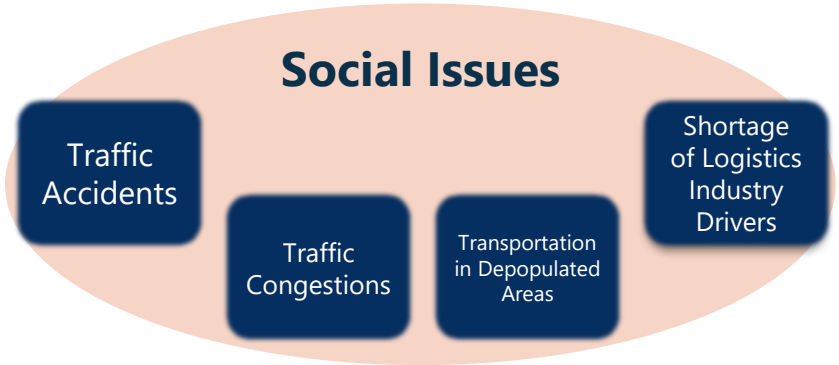
1. Background and Objectives

Backgrounds

- In the second phase of the SIP, to overcome a wide range of technological difficulties necessary for the practical application of automated driving, focus on the preparation environment for automated driving vehicles and the development of fundamental technologies needed to ensure safety as cooperative areas. In the study of preparing the driving environment, the format and communication requirements for road traffic information necessary for automated driving were determined, and the aim was to standardize these requirements.
- This research is positioned as "Utilization technology for road traffic environment data," and is intended to contribute to the appropriate supply of traffic regulation information needed by automated vehicles, including the development of technology for simply, extensively, and efficiently collecting traffic regulation information automatically and improving the accuracy of traffic regulation information data.。



- **Development of Environment for Automated Vehicles**
- **Infrastructure Technology Development for Ensuring Safety**

Creating a Safe and Secure Society for All to Move

Objectives

- Developing a model system and conduct FOTs to **improve the data accuracy of traffic regulation information** managed by the police, which is needed by automated vehicles.
- Conduct surveys and studies to investigate and consider the introduction of the developed system to all prefectural police forces.

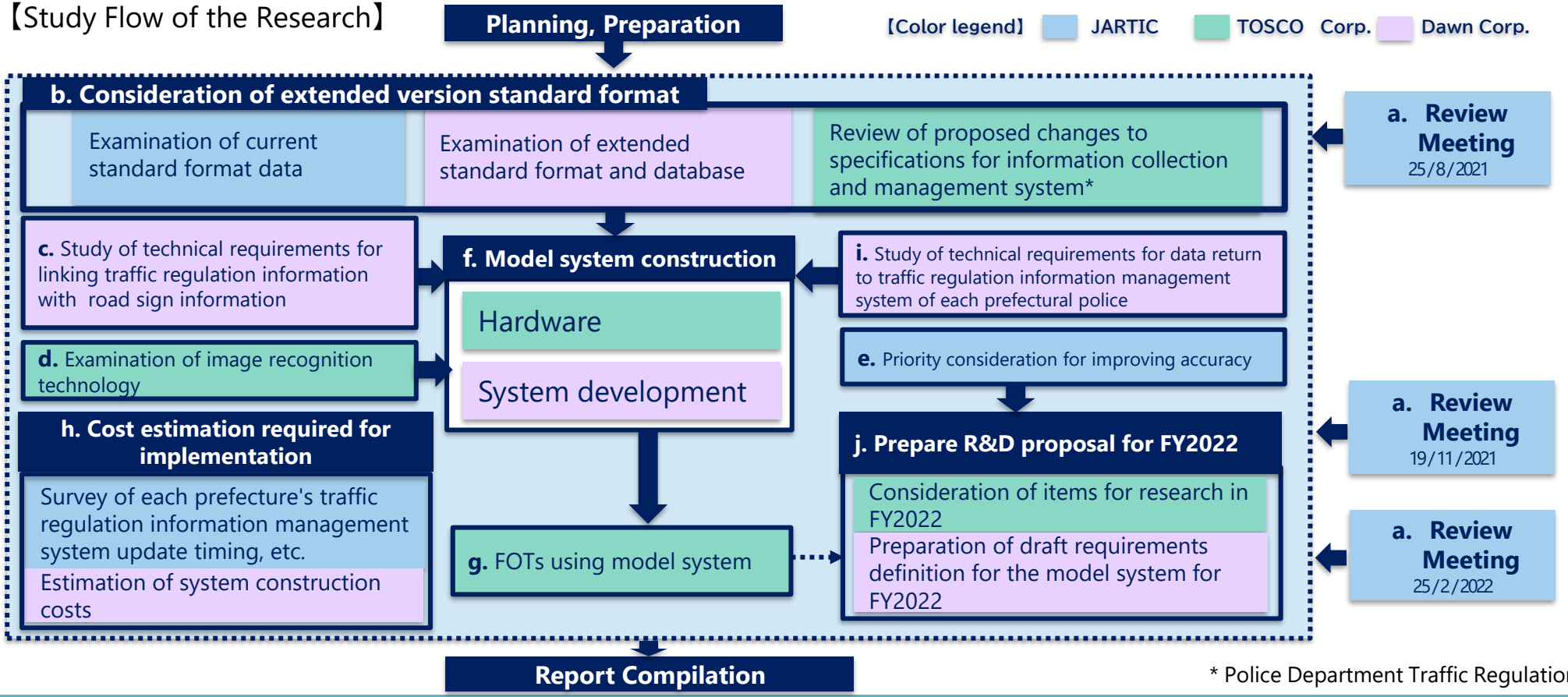
2. Outline of Research

Implementation objective (2021)

① To develop an extended standard format that links traffic regulation information with road sign information in order to improve the data accuracy of traffic regulation information required by automated vehicles.

② To construct a model system to improve the data accuracy of traffic regulation information, conduct FOTs, and prepare a system requirements definition to build a prototype system in FY2022 for social implementation.

【Study Flow of the Research】



* Police Department Traffic Regulation

2. Outline of Research

【Schedule of 2021】

Research Items	Process									Remarks
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Plannning/ preparation										
a. Impementation of Review Meeting										
b. Consideration of extended version standard format										
Analysis of current standard format data										
Consideration of extended standard format and database										
Review of proposed changes to specifications for information collection and management system										
C. Study of technical requirements for linking traffic control information with sign information										
d. Examination of image recognition technology										
e. Priority consideration for improving accuracy										
f. Model system construction										
Hardware										
System development										from December: repair
g.Demonstration experiment using model system										
h. Cost estimation required for implementation										
Survey of each prefecture's traffic control information management system update timing, etc.										
Estimation of system construction costs										
i.Study of technical requirements for data return to traffic control information management system of each prefectural police										
J. Prepare R&D proposal for FY2022										
Consideration of items for study in FY2022										
Preparation of draft requirements for the model system for FY2022										
Report Compilation										Period: March 31

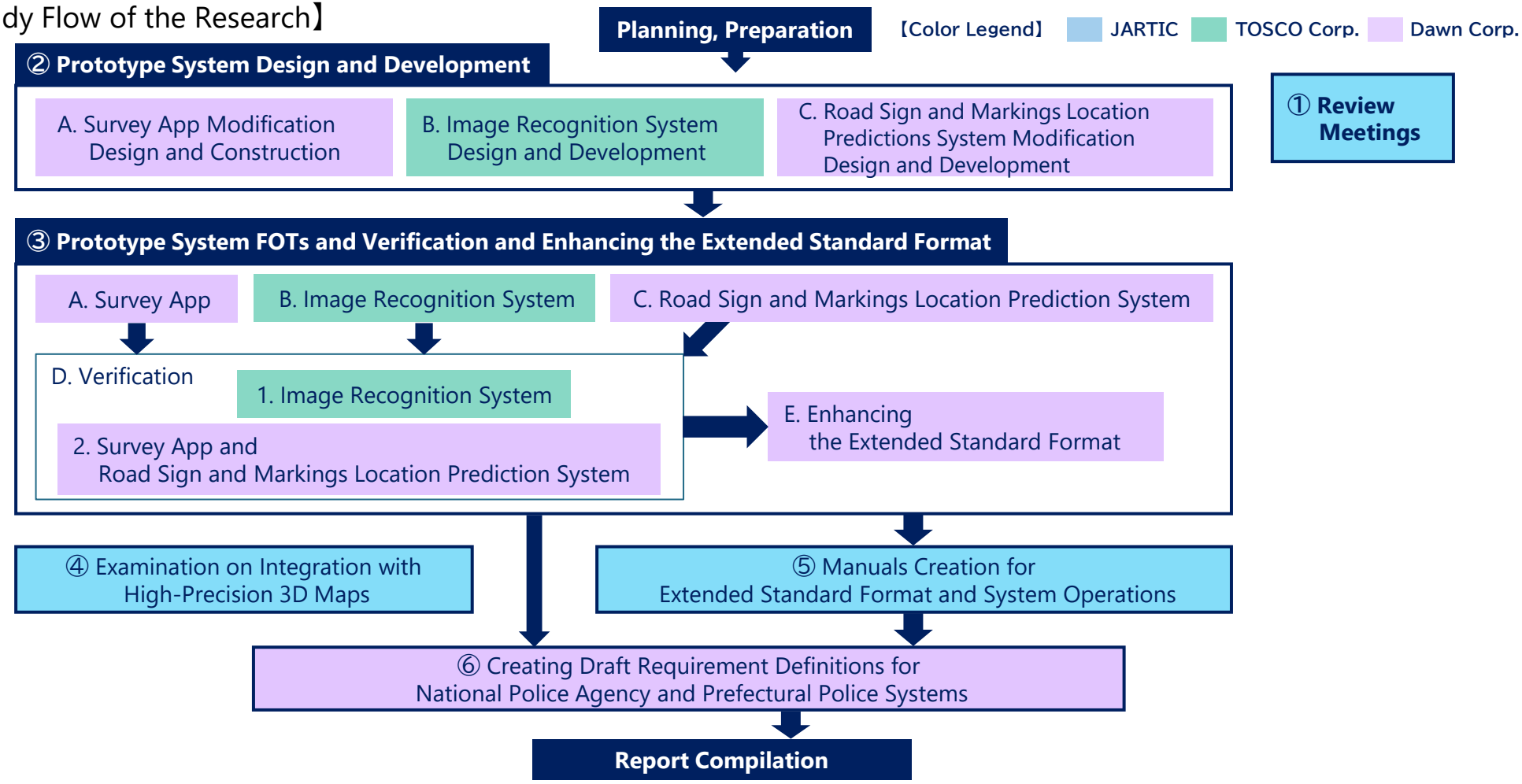
2. Outline of Research

Implementation objective (2022)

Developing a prototype system and conducting FOTs would improve the accuracy of traffic regulation information, which is necessary for automated vehicles, and managed by the police.

Prepare a draft requirements document for the introduction of the functions into the traffic regulation information management system of the National Police Agency and Prefectural Police.

【Study Flow of the Research】



2. Outline of Research

【Schedule of 2022】

Research Items	Process												Remarks
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
① Review Meetings		→	▼			→	▼			→	▼		3 times
② Prototype System Design and Development													
A. Survey App Modification Design and Construction													
B. Image Recognition System Design and Development													
C. Road Sign and Markings Location Predictions System Modification Design and Development													
D. Hardware Acquisition, Installation, and Management for Prototype System													
③ Prototype System FOTs and Verification and Enhancing the Extended Standard Format													
A. Survey App													
B. Image Recognition System													
C. Road Sign and Markings Location Prediction System													
D. Verification													
D-1. Image Recognition System													
D-2. Survey App and Road Sign and Markings Location Prediction System													
E. Enhancing the Extended Standard Format													
④ Examination on Integration with High-Precision 3D Maps													
⑤ Manuals Creation for Extended Standard Format and System Operations													
⑥ Creating Draft Requirement Definitions for National Police Agency and Prefectural Police Systems													
⑦ Report Compilation									→				

3. Model System Development and FOTs

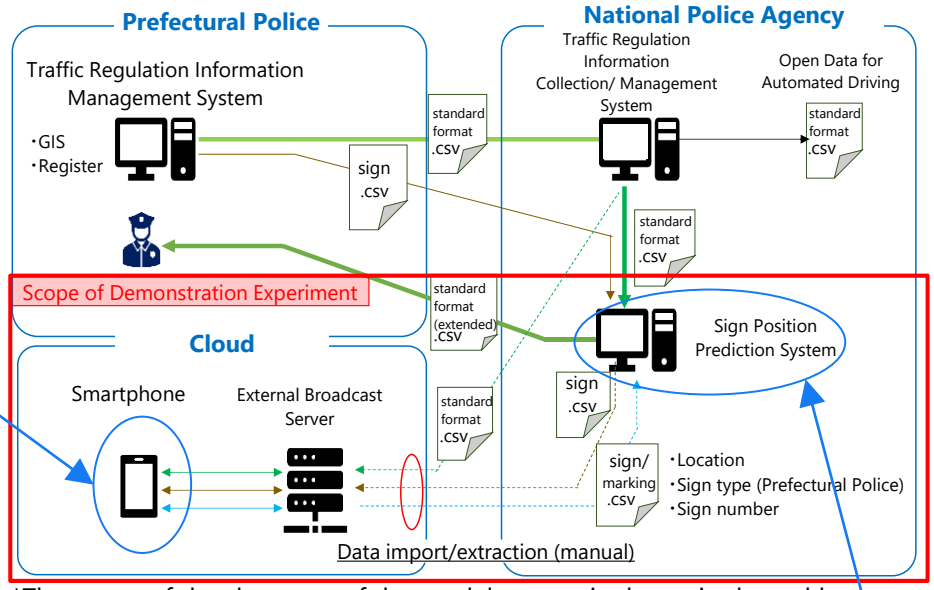
3-1. Model System Development

Based on the draft requirements definition prepared in the FY2020 research, a road sign location prediction system and survey application were developed to improve the accuracy of traffic regulation information.

Survey App

The survey application was developed as an application with the following functions, including registration of survey results, to support field surveys of road signs and markings.

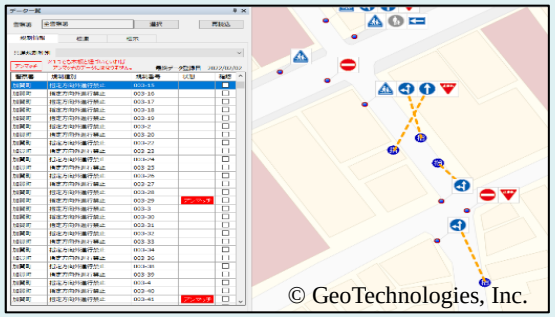
Administrator function（PC）	User function（smartphone）
Login function	Login / user authentication function
User authentication and management function	Traffic regulation information display function
Traffic regulation information registration function	Traffic regulation information correction function
Traffic regulation information mapping function	Survey information registration function
Correction history function	Operation manual display function
Data output function	-



*The scope of development of the model system is shown in the red box.

Road Sign Location Prediction System

System to support linking traffic regulation data with road sign data



Basic function
Traffic regulation information and road sign screen display function
Survey application acquisition information screen display function
Search function for traffic regulation information and road signs
Road sign position prediction function
Function to link traffic regulation information with road signs
Function to display unmatched
Function to output traffic regulation information to a file

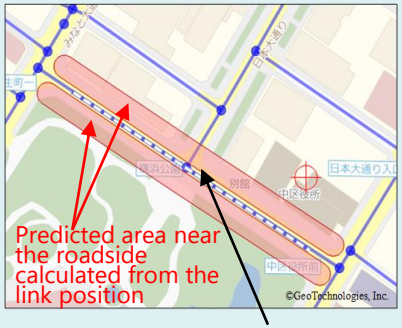
[Examples]

Prediction of point regulation

Example of predicted area of point regulation employing node information

Predicting Line Regulations

Example of predicted area of line regulation on a two-way road

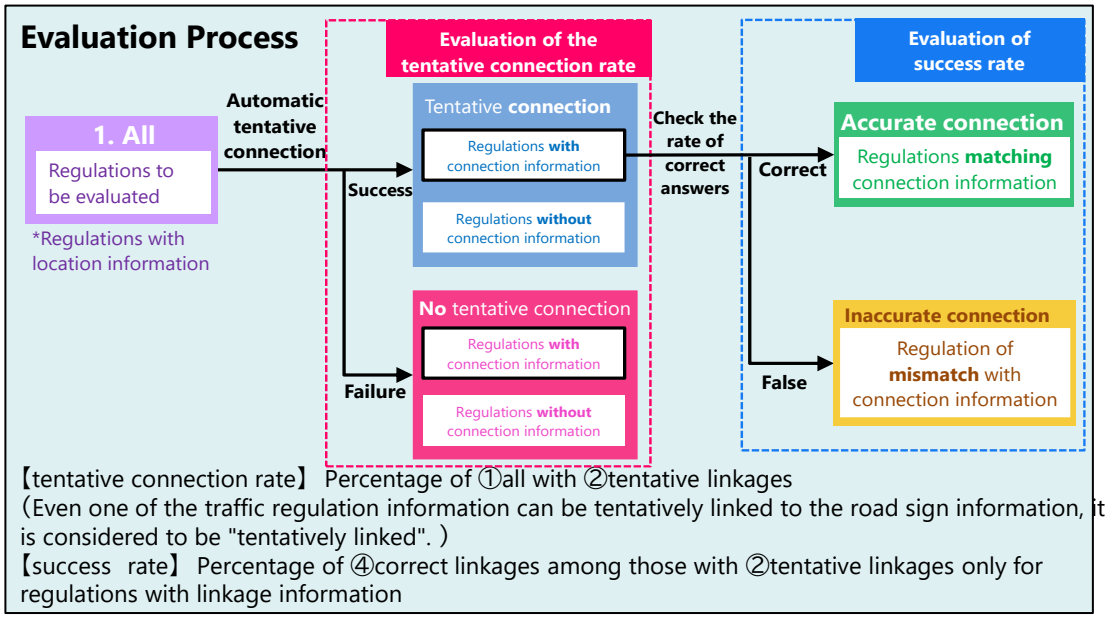


3. Model System Development and FOTs

3-2. FOTs

FOTs were conducted using the developed model system in jurisdiction of three police stations of the Kanagawa Prefectural Police.

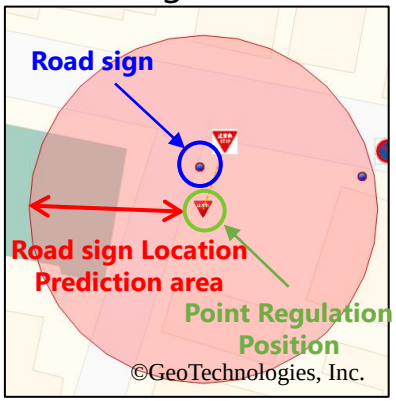
Item	Outline
Period	January 2022- February 2022
objective	Road Sign Position Prediction System & Survey App
Area	The three districts of Kanagawa Prefectural Police Stations (Kagacho, Yamate, Isezaki)
Data	・Standard format data (28 types/ 4,113 cases) ・Road sign and marking data
Process	1. Register the standard format data and road sign data of the implementation area in the road sign position prediction system, and tentatively link them together. 2. Reviewed the prediction method based on the results of Step 1 and verified the optimal prediction method. 3. Verify the accuracy of the matching by comparing with the connection information at Kanagawa Prefectural Police. 4. Repeat Steps 2 and 3. 5. Confirm the results of the mapping, and conduct a field survey using the Survey App for areas where the accuracy is low. 6. Verify the tentative linkage rate and the correct answer rate.
Other	There were 41 regulation types existing in the test area, of which "regulation types that do not require road sign under traffic regulation standards " and "regulation types for which no location information is registered in the test data" were excluded.



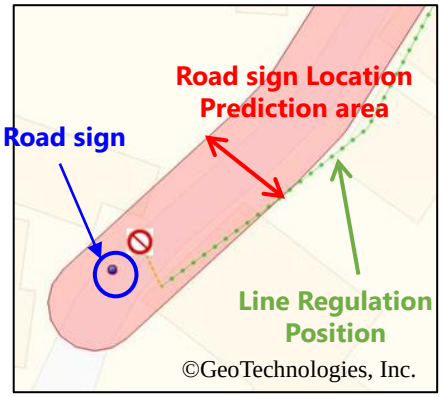
【tentative connection rate】 Percentage of ①all with ②tentative linkages
(Even one of the traffic regulation information can be tentatively linked to the road sign information, it is considered to be "tentatively linked".)
【success rate】 Percentage of ④correct linkages among those with ②tentative linkages only for regulations with linkage information

Evaluation Method

- ✓ Evaluation of the "tentative rate" and "correct answer rate" of traffic regulation data was conducted using the flow shown in the figure above.
- ✓ The evaluation was conducted a total of five times while improving the prediction method.
- ✓ Traffic regulation data that could be tentatively linked to one or more road sign data was treated as successful data.



[Point Regulation] Successful examples



[Line Regulation] Successful examples

3. Model System Development and FOTs

3-3. Verification of Road Sign Location Prediction System

The final tentative connection rate using the road sign location prediction system was 91.5%, and the correct answer rate was 93.8%.

Number of trial	Number of regulations	Number of exclusions	Number of tentative connections	Number of no tentative connections	Rate of tentative connections	Number of correct answers to be evaluated	Number of correct answers	Rate of correct answers
1st	4,113	0	1,812	2,301	**44.1%**	1,554	1,452	**93.4%**
2nd	4,113	1,090	1,812	1,211	**59.9%**	1,554	1,452	**93.4%**
3rd	4,113	1,090	2,580	443	**85.3%**	2,227	2,118	**95.1%**
4th	4,113	1,090	2,634	389	**87.1%**	2,287	2,181	**95.4%**
5th	4,113	1,090	2,767	256	**91.5%**	2,389	2,240	**93.8%**

3-4. Verification of the Survey App

Field surveys were conducted on 27 targeted cases using the Survey App, and all were tentatively connected.

【Overview of the FOTs Using the Survey App】

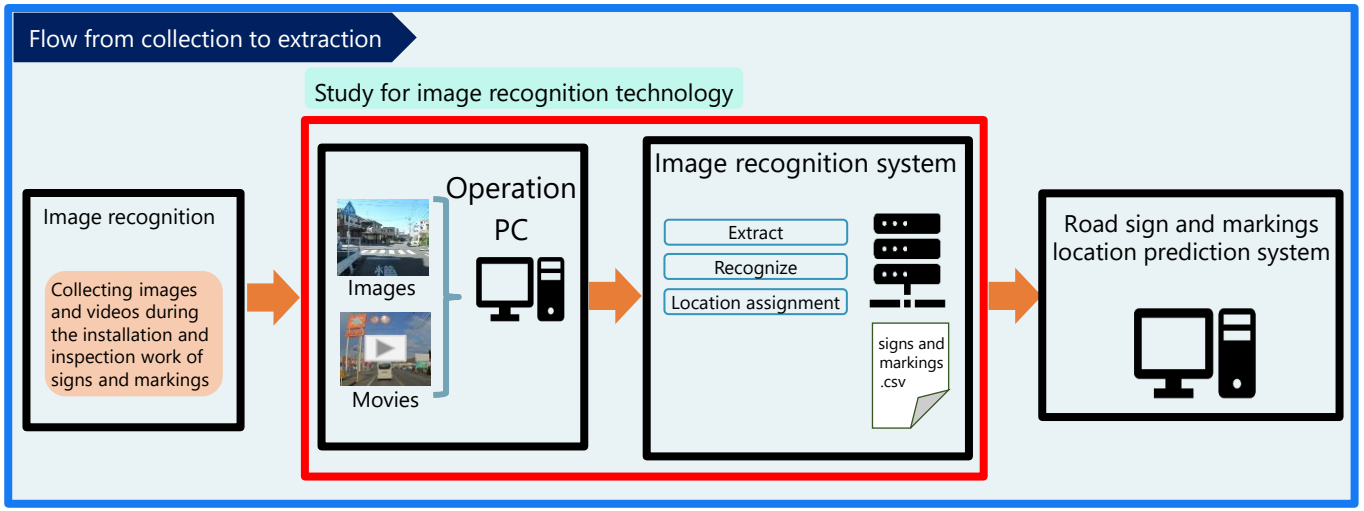
Of the 211 traffic restrictions in the entire Yamashita-cho area in the model region, FOTs were conducted using the survey application for 27 data that could not be tentatively linked by the road sign location prediction system.

Target regulation	Number of regulations	Type of regulation
Point	23	Pedestrian crossings, stop control, turning prohibition
Line	4	Pedestrian walkways, maximum speed 30km/h, No turning

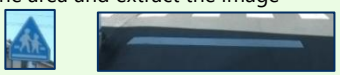
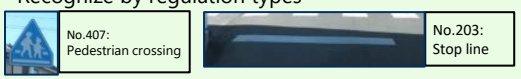
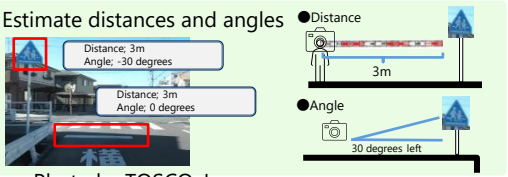
No.	Number of regulations	Number of exclusions	Number of tentative connections	Number of no tentative connections	Rate of tentative connections
1	27	0	27	0	100%

3-5. Verification of the Image Recognition System

A method was investigated for facilitating the collection and extraction of location information of signs and markings from image data collected by prefectural police during the installation and inspection work of signs and markings.



The study assumed the following processing for extraction, recognition, and distance estimation techniques.

Process	Explanation	Examples
Extract	Identifying areas from images and movies that are likely to be road signs or markings, and extracting images from these areas	Identify the area and extract the image  Photo by TOSCO, Inc.
Recognize	Determine whether the extracted area image is the correct road sign or marking and identify the regulation types	Recognize by regulation types  Photo by TOSCO, Inc.
Location assignment	Calculate the latitude and longitude of a sign or marked object in the image by predicting the distance and angle based on the captured position information contained in the video and images	Estimate distances and angles  Photo by TOSCO, Inc.

Prototype evaluation software using machine learning methodology techniques for evaluation

3-6. Image Recognition Technology Evaluation and Verification

a: Extraction

The extraction result was more than 95% using 200 pictures and 34 minutes of running video, including images of adverse conditions such as rainy weather and deterioration. Regarding markings, stop lines, crosswalks, directional signs, and maximum speed instructions were evaluated, with an average result of 95%. Regarding markings, stop lines, pedestrian crossings, directional signs, and maximum speed were evaluated, with an average performance of 95%.

Type of signs	Number of signs/ markings	Number of extracted images	Extraction rate
Main sign picture	297	281	95%
Auxiliary sign picture	131	129	98%
Main sign video	219	214	98%
Auxiliary sign video	112	111	99%
Markings	261	248	95%

b: Recognition

A total of 297 images for evaluation were validated by extracting the sign portion from the extracted images. Although there were cases in which the system misrecognized a lane-use control as a one-way , the recognition rate improved with re-training.

Class	Number of signs/ markings	Number of recognized images	Recognition rate
Parking prohibition	106	106	100%
maximum speed 40km/h	15	15	100%
Pedestrian crossing・Bicycle crossing	14	14	100%
Turning prohibition	13	13	100%
Lane-use control * after re-learning	11	3 (11)*	27% (100%)*
Maximum speed 50km/h	11	11	100%
...(omitted)			
Total	297	274	92.3%

c: Location Estimation

The system determined 1,600 images for evaluation with measured distance data with depth estimation algorithms and regression equation models. Of these, 96% could be estimated within a margin of error of 2 meters (error between actual and inferred distances).

Classification of errors	Number of evaluation (1,600)	Percentage
Within 2m	1,539	96.2%
Between 2 and 4m	59	3.7%
Beyond 4m	2	0.1%

Lane-use control

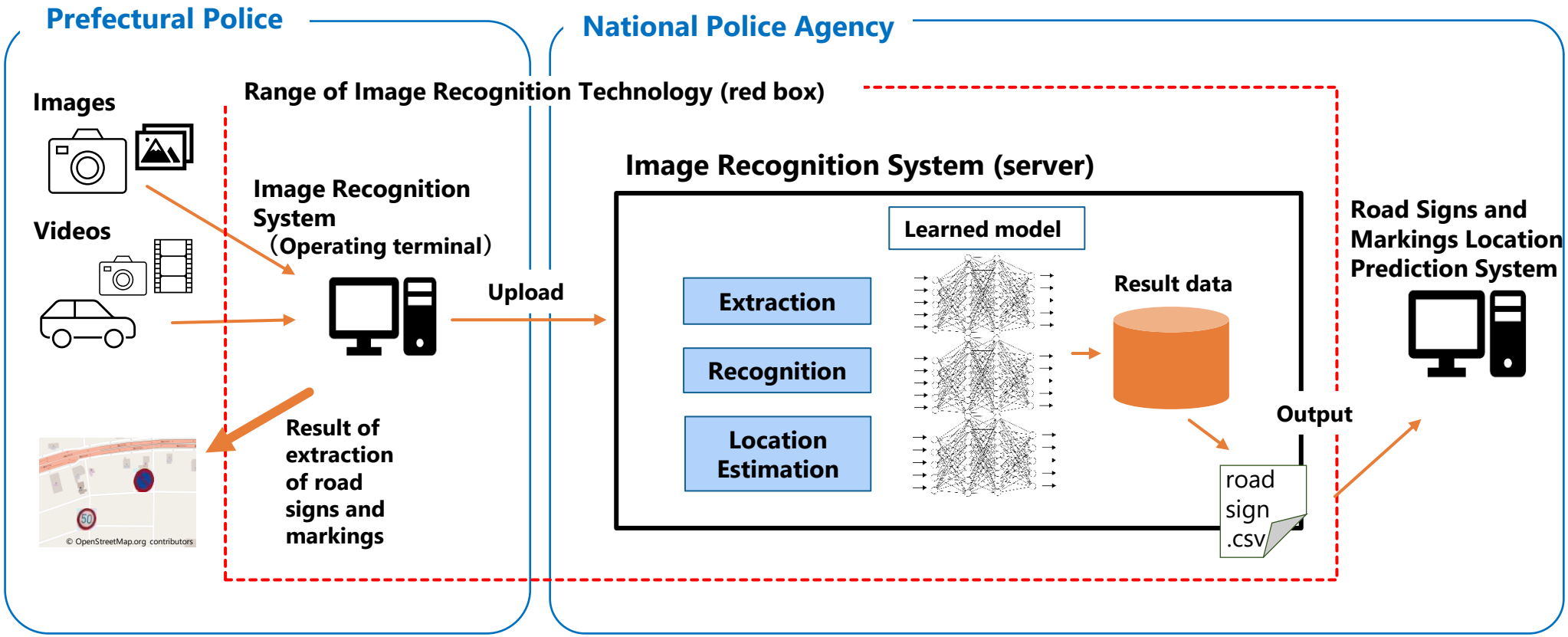
One-way

3-7. Examination of the Image Recognition System

The system configuration takes into account the results of the technical survey. By constructing a system with the following configuration, a large amount of location information on signs and markings can be collected and extracted from video and still images in batches.

Features

- Simple and easy operation
- A batch system with server



4. Prototype System FOTs and Verification

4-1. Design and Development of a Prototype System

A prototype system consisting of a sign and mark location prediction system, a survey application, and an image recognition system was constructed, with additional functions to the model system developed and tested in FY2021.

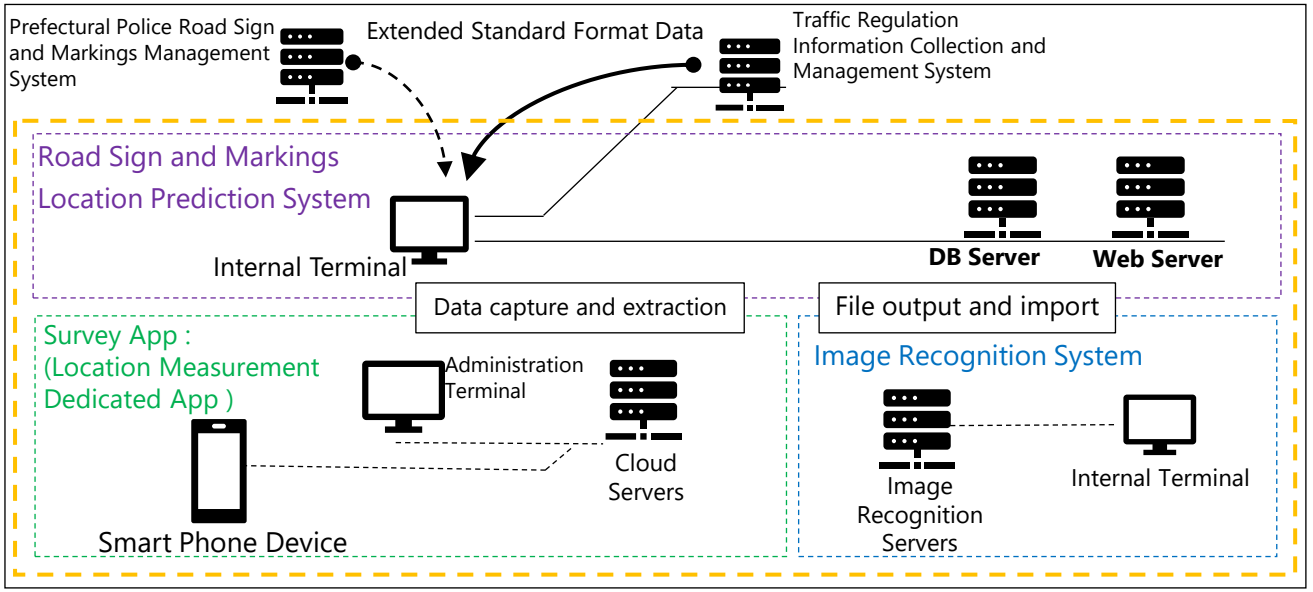
【New Functionalities : Road Sign and Markings Location Prediction System】

- Temporary linking of traffic regulation data with road marking data
- Registration support for direction of regulation
- Registration of auxiliary road signs
- Adaptation to extended standard format data
- On-screen display and search for unmatched data
- Easy registration of traffic regulation data
- Registration and display of road sign and markings inspection image information
- Discrimination of data with result confirmation of tentatively linked data
- Individual setting of forecast range and forecast method

【New Functionalities : Survey App】

- Adaptation to extended standard format data
- Registration of investigation information (auxiliary road signs, regulation direction)
- Temporary linking of traffic regulation data and road markings data
- Registration support with the image recognition system

Overall Architecture of Prototype System



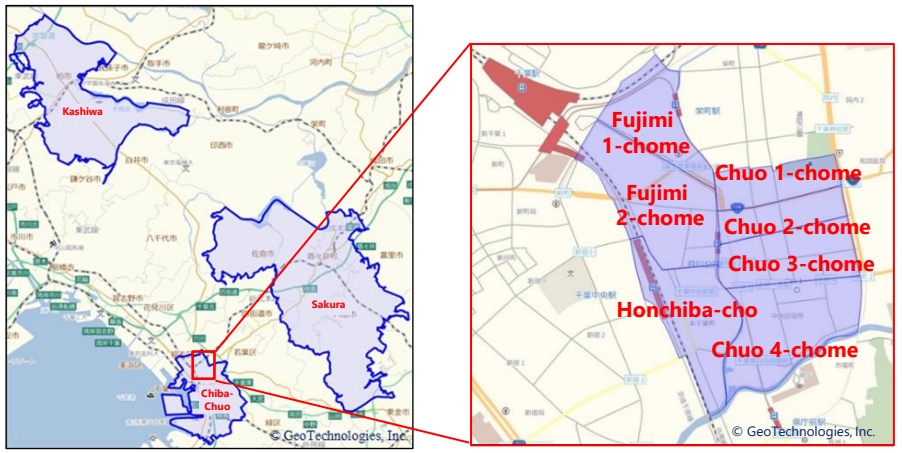
4. Prototype System FOTs and Verification

4-2. FOTs

The prototype system was used in a FOT in target areas of the Chiba Prefectural Police.

Item	Outline
Period	October-December, 2022
Subject	Image recognition system, Road sign and marking location prediction system, the Survey App
Area	Chiba Prefectural Police Target Area
Data	・Extended Standard Format Data（Traffic Regulation Data*, Road Sing and Markings Data, Linked Data） ・Road Sign and Markings Data (Including Images) Generated by Survey App and Image Recognition System *Road Signs Data : 14,303 cases of 21 types *Road Markings Data : 472 cases of 15 types
Process	① Collect digital information on road signs and markings in targeted areas using dashboard cameras and the survey app. ② The collected road sign and marking information is imported into a prototype system (e.g., the road sign and markings location prediction system) and automatically matched with traffic regulation information to confirm data consistency between traffic regulation information and road sign and markings. ③ For road sign and markings with inconsistent data, conduct a field surveys and re-check the data consistency to determine the optimal method for improving the accuracy of the traffic regulation information data. ④ In the prototype system (e.g., image recognition system), investigate how to support the registration of traffic regulation information by using the collected road sign and marking information.
Others	Of the 41 regulation types held by the Chiba Prefectural Police, those that existed in 11 or more cases were the subject of the experiment.

【Target Areas of the Road sign and marking location prediction system and the Survey App】



(Upper left) FOTs experiment area for evaluating the linking of traffic regulation information and road sign data.
(Upper right) FOTs experiment area for evaluating the linking of traffic regulation information and road making data.

【Target Areas of the Image recognition system】

● **Urban** Fujimi 1,2-chome

● **Residencial** Wakaba-cho, Kashiwa City

● **Industrial** Kawasaki-cho, Chuo-ku

● **Suburban** Mawatashi, Sakura City

● **Route-Based** Prefectural Route 65 (Suburban), Prefectural Route 116 (Including Mountains Area)

4. Prototype System FOTs and Verification

4-3. Verification

a: Image Recognition System

■Extraction and Recognition Accuracy

Extraction rate：Percentage of road signs/markings extracted out of the data used to determine correct answers
Recognition rate：Percentage of signs/markings correctly recognized in the extracted data

<road signs>

Area	Urban Area		Industrial Area	Residential Area	Suburban Area	Route-Based Area	
	Fujimi 1-chome	Fujimi 2-chome	Kawasaki-cho	Wakaba-cho Kashiwa City	Mawatashi Sakura City	Prefectural Route 65	Prefectural Route 116
Number of road signs	164	276	57	83	36	369	92
Number of extraction (Extraction rate)	146 (89.0%)	246 (89.1%)	34 (59.7%)	76 (91.6%)	35 (97.2%)	286 (77.2%)	57 (62.0%)
Number of recognition (Recognition rate)	144 (98.6%)	241 (97.9%)	34 (100.0%)	74 (94.8%)	34 (97.1%)	274 (95.8%)	55 (96.5%)

<road markings>

Area	Urban Area		Industrial Area	Residential Area	Suburban Area	Route-Based Area	
	Fujimi 1-chome	Fujimi 2-chome	Kawasaki-cho	Wakaba-cho Kashiwa City	Mawatashi Sakura City	Prefectural Route 65	Prefectural Route 116
Number of road markings	80	165	131	59	41	333	103
Number of extraction (Extraction rate)	65 (81.3%)	143 (86.7%)	93 (71.0%)	48 (81.3%)	31 (75.6%)	240 (72.1%)	85 (82.5%)
Number of recognition (Recognition rate)	65 (100.0%)	143 (100.0%)	93 (100.0%)	45 (93.8%)	25 (80.7%)	235 (97.9%)	84 (98.8%)

Not applicable: Linear regulations such as “No Passing” and textual markings like “駐禁(No parking)” and “止まれ,とまれ(Stop)"

4. Prototype System FOTs and Verification

■Position Estimation Accuracy

Compare the image recognition processing results that are correctly extracted and recognized with the road sign and marking locations in the data for determining the correct answer.

<road signs> Values in the leftmost table (xx-xx m) are location errors.

Area	Urban area		Industrial area	Residential area	Suburban area	Route-based	
	Fujimi 1-chome	Fujimi 2-chome	Kawasaki-cho	Wakaba-cho Kashiwa City	Mawatashi Sakura City	Prefectural Route 65	Prefectural Route 116
0-9m	59	120	14	41	8	68	19
10-9m	58	96	10	24	18	135	23
20-29m	17	21	5	8	6	52	9
30m or more	10	4	5	1	2	19	4
Percentage of 0-9m	41.0%	49.8%	41.2%	55.4%	23.5%	24.8%	34.5%

<road markings> Values in the leftmost table (xx-xx m) are location errors.

Area	Urban area		Industrial area	Residential area	Suburban area	Route-based	
	Fujimi 1-chome	Fujimi 2-chome	Kawasaki-cho	Wakaba-cho Kashiwa City	Mawatashi Sakura City	Prefectural Route 65	Prefectural Route 116
0-9m	39	65	64	29	22	84	34
10-9m	15	59	28	16	3	127	41
20-29m	5	16	1	0	0	24	8
30m or more	6	3	0	0	0	0	1
Percentage of 0-9m	60.0%	45.5%	68.8%	64.4%	88.0%	35.7%	40.5%

4. Prototype System FOTs and Verification

4-3. Verification

b: Road Sign and Markings Location Prediction System

○ [Matching Traffic Regulations and Road Signs]:
The final tentative linkage rate was "92.7%." The correct answer rate was "99.4%."

Number of trials	Number of regulations	Number of exclusions	Number of tentative connections	Number of no tentative connections	Rate of tentative connections	Number of correct answers to be evaluated	Number of correct answers	Rate of correct answers
1st	14,303	0	11,062	3,241	77.3%	10,721	10,649	99.3%
2nd	14,303	2,200	11,062	1,041	91.4%	10,721	10,649	99.3%
3rd	14,303	2,230	11,186	887	**92.7%**	10,831	10,767	**99.4%**

○ [Matching Traffic Regulations and Road Markings]:
The final tentative linkage rate was "95.3%." The correct answer rate was "99.7%."

Number of trials	Number of regulations	Number of exclusions	Number of tentative connections	Number of no tentative connections	Rate of tentative connections	Number of correct answers to be evaluated	Number of correct answers	Rate of correct answers
1st	472	0	343	129	72.7%	342	341	99.7%
2nd	472	71	343	58	85.5%	342	341	99.7%
3rd	472	109	346	17	**95.3%**	345	344	**99.7%**

*Regulations excluded in the second trial: Regulation data for which the installation of signs and markings is not required according to the "Installation Standards for Traffic Regulation Standards
e.g.) Pedestrian crossing signs at locations where traffic signals are installed
*Regulations excluded in the third trial: Regulation data for which the installation of signs and markings is not required according to the "results of the preliminary investigation."
e.g.) Regulatory data that were confirmed to have been abolished

4. Prototype System FOTs and Verification

4-3. Verification

c: Survey App

Added functionality to connect with image recognition system to shorten registration time

Nov. 4, 2022
Photo by Dawn, Inc.

2021

The registration process was complicated by the need to select the appropriate main road sign on the post from a choice of over 100 main road signs, as the candidates were not narrowed down by image recognition.

2022

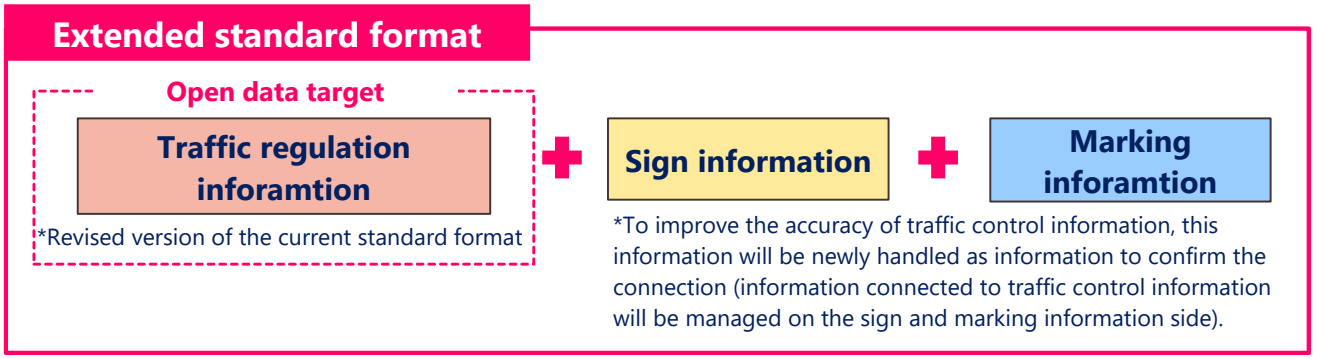
Image recognition narrows down the candidates so that only the target main sign on the post is automatically displayed as a candidate, making the selection easier.

In 2021, the work took about 60-120 seconds,
while the work time was reduced to about 40-70 seconds in 2022.

5. Extended Standard Format and Manuals

5-1. Examination of Extended Standard Format

- Since the current standard format has structural issues, the "Extended Standard Format" was considered to solve the problems.
- To improve the accuracy of traffic regulation information, it is necessary to centrally manage the linkage of the signs and markings corresponding to that information, so the Extended Standard Format has the following structure.



(1) Review of regulation types

- The regulation types were consolidated from the current 103 to 73 according to the registration status of the standard format data of the Prefectural Police and the results of the review based on the correspondence with the traffic regulation standards.

(2) Review of current standard format

- Based on users' opinions on the current standard format, the current registration data were analyzed and issues were identified, and information items that should be defined as the Extended Standard Format were examined.
- Finally, the information items were organized into 170 items (the current standard format has 224 items).

(3) Examination of items of road sign and marking

- Since improving the accuracy of traffic regulation information requires data consistency checks by linking the data with the road sign and marking information corresponding to each regulation, the minimum data format required to manage the linking information was considered.

(4) Gathering opinions from stakeholders

- Interviews were conducted with four cartographic companies from Sept to Oct 2021 to collect requests for improvement regarding issues with the current Standard Format data, clarification of specifications, and provision with differential data.
- From 26 Nov to 13 Dec 2021, a questionnaire survey on the review of the current Standard Format was conducted among the Prefectural Police to collect issues and consider responses.

5. Extended Standard Format and Manuals

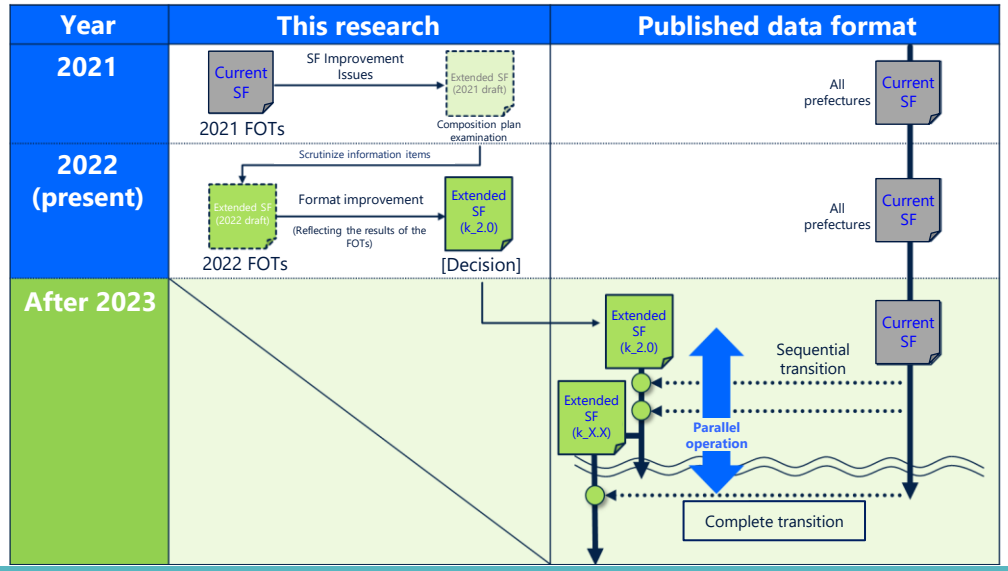
(5) Definition of Registration Categories

- Four new registration categories were defined for each traffic regulation information item, considering the need for the information to represent traffic regulation.

Registration Category	Content	Example
Required	Items that must be registered to represent traffic regulation information	Common regulation type codes, unique keys by Prefectural Police, longitude and latitude of the regulation location, e.g.
Conditionally Required A	Items that must be registered to represent traffic regulation information when the item concerned is of a specified regulation type.	The entry direction (coordinates), the prohibited direction (coordinates), the specified direction (coordinates), and the speed, e.g.
Conditionally Required B	Items that must be registered to represent traffic regulation information only if the regulation type for which the item is specified is applicable, but only according to the content of the regulation.	Exempted sections and areas, regulatory conditions (subject to; periods, hours, days, and vehicles of exclusion), e.g.
Optional	Items that register data voluntarily held by the Prefectural Police as a reference for traffic regulation information (Items that are not necessarily held by the respective Prefectural Police)	Intersection name, (representative) route name, distance/extension, and area, e.g.

(6) Future Operational Plan

- After 2023, the Extended Standard Format will be gradually offered by the Prefectures whose systems have been renovated to support the new format.
- For the time being, the current Standard Format and the Extended Standard Format will be used in parallel.
- The Extended Standard Format will be reviewed and revised as necessary, and the manual on the next page will be updated too.

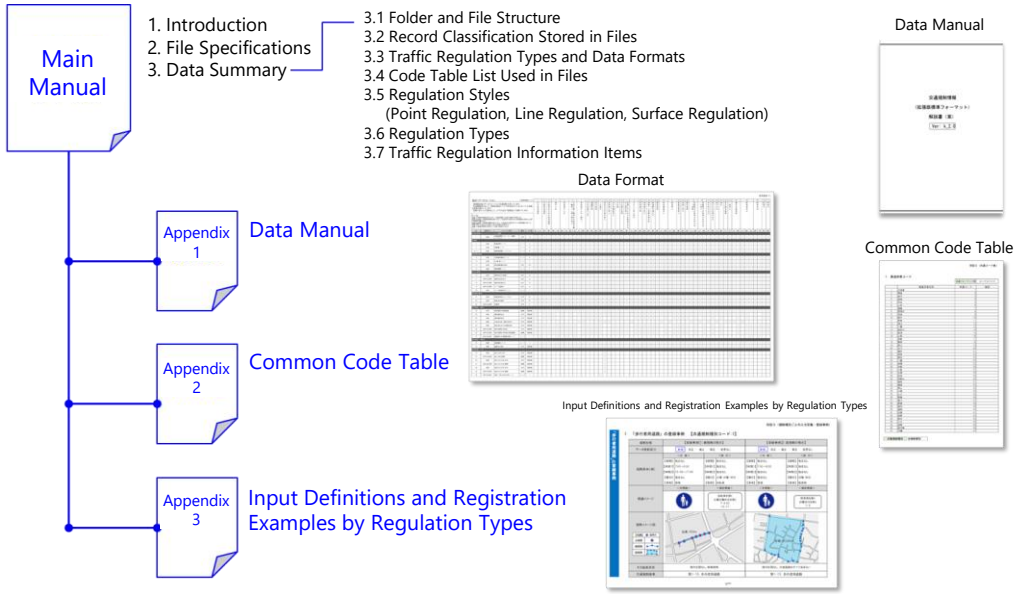


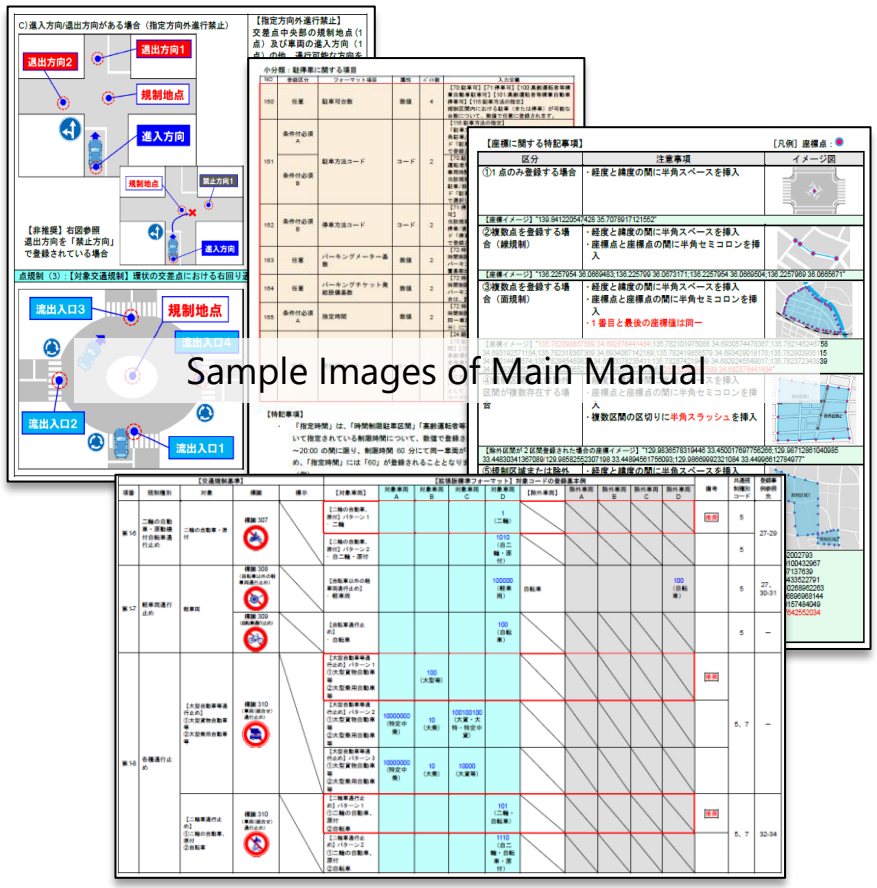
5. Extended Standard Format and Manuals

5-2. Examination of Extended Standard Format Manual

- For prefectural police to accurately register traffic regulation information, the definitions of regulation type and each format item were clarified, and the manual was prepared to help open data users understand the data format.
- The Extended Standard Format manual consists of the main document, which explains file specifications and input definitions for each information item, and the data format for 73 regulation types; Appendix 1, common code table; Appendix 2, input definitions and registration examples for each regulation type; Appendix 3, as separate documents.
- In the preparation of this manual, opinions were solicited three times from the Prefectural Police, who are the information registrants, and cartographic companies, who are the information users, to address issues that were gathered.

Manual Structure





Opinion inquiry status

Time	Priority	Period	Number of opinions
1	Priority 1 : 11 types	Aug. 31 - Sept. 9, 2022	75
2	Priority 2 : 33 types	Oct. 18 - 31, 2022	36
3	Priority 3,4 : 29 types	Dec. 9-23, 2022	58

5. Extended Standard Format and Manuals

5-3. Development of System Operation Manual

- The roles of each system incorporated in the prototype system were organized as functions, and an operation manual was created to enable the user to understand the sequence of steps to improve the data accuracy of traffic regulation information.
- The system operation manual clarifies the operation procedures and tasks of prefectural police personnel and refers to the operation manuals for each function as a method of operation to carry out these works.
- In preparing the manual, opinions were solicited from prefectural police and the system manufacturer, and issues were addressed.

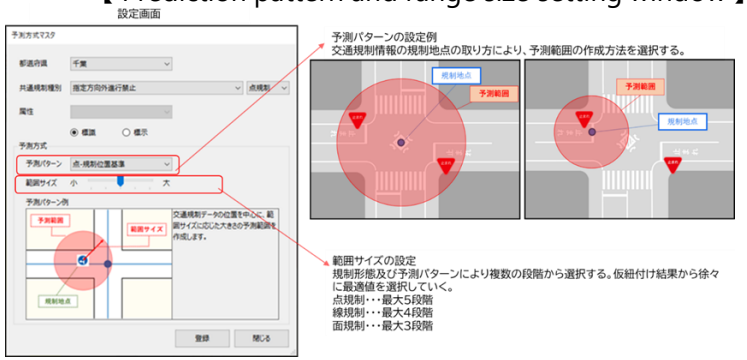
System Operation Manual Structure

Main Manual

1 Introduction
2 About the System
  2.1 Purpose of the System
  2.2 System Configuration
  2.3 System Functions
  2.4 Differences between the Image Recognition Function and the Road Sign and Markings Collection Function
3 System Operation
  3.1 Operation Flow
    3.1.1 Flow of Using Road Signs and Markings Data Held by Prefectural Police
    3.1.2 Flow of Using New Road Signs and Markings Data
  3.2 Methods of Tentative Linking Using the Function for Linking Traffic Regulation Information to Road Signs and Markings
    3.2.1 Flow of Tentative Linking Using the Function for Linking Traffic Regulation Information to Road Signs and Markings
    3.2.2 Setting Values for Traffic Control Information ; Decision-Making Information
    3.2.3 Checking Data that Cannot be Tentatively Linked
  3.3 Workflow for Collecting Road Signs and Markings Information
    3.3.1 Collecting Road Signs and Markings Information with the Road Signs and Markings Collection Function
    3.3.2 Collecting Road Signs and Markings Information Using Image Recognition Function
4 Examples of Use

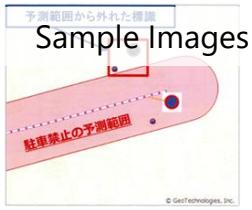
- Appendix 1: Operation Manual; Traffic Regulation Information and Road Signs and Markings Linking Function
- Appendix 2: Operation Manual; Road Signs and Markings Collection Function
- Appendix 3: Operation Manual; Image Recognition Function

【 Prediction pattern and range size setting window 】



【 Examples of temporary linkage failures, causes, and countermeasures 】

(1)位置予測範囲外に標識･標示データがある場合



原因	対応案
交通規制情報に対する位置予測範囲が狭すぎる。	予測方式の設定において、「範囲サイズ」を変更する。
交通規制情報に対する位置予測範囲の作成方法が適切でない可能性がある。	①「交通規制情報と標識・標示データの組合せの設定」を確認する。 ②予測方式の設定において、「予測パターン」を変更する。

(2)交通規制周辺に標識データ又は標示データが存在しない場合

原因	対応案
標識・標示データが作成されていない。	現地調査を行い、標識・標示収集機能または画像認識機能を用いて標識・標示データを作成する。
交通規制データの位置情報が間違っている。	意思決定から交通規制情報の位置情報を確認する。

Sample Images of Main System Operation Manual

Times	Target	Period	Number of Opinions
1	National Police Agency, Prefectural Police, System manufacturer	Dec. 28, 2022 - Jan. 13, 2023	14

6.Draft Requirements Definition for Police Systems

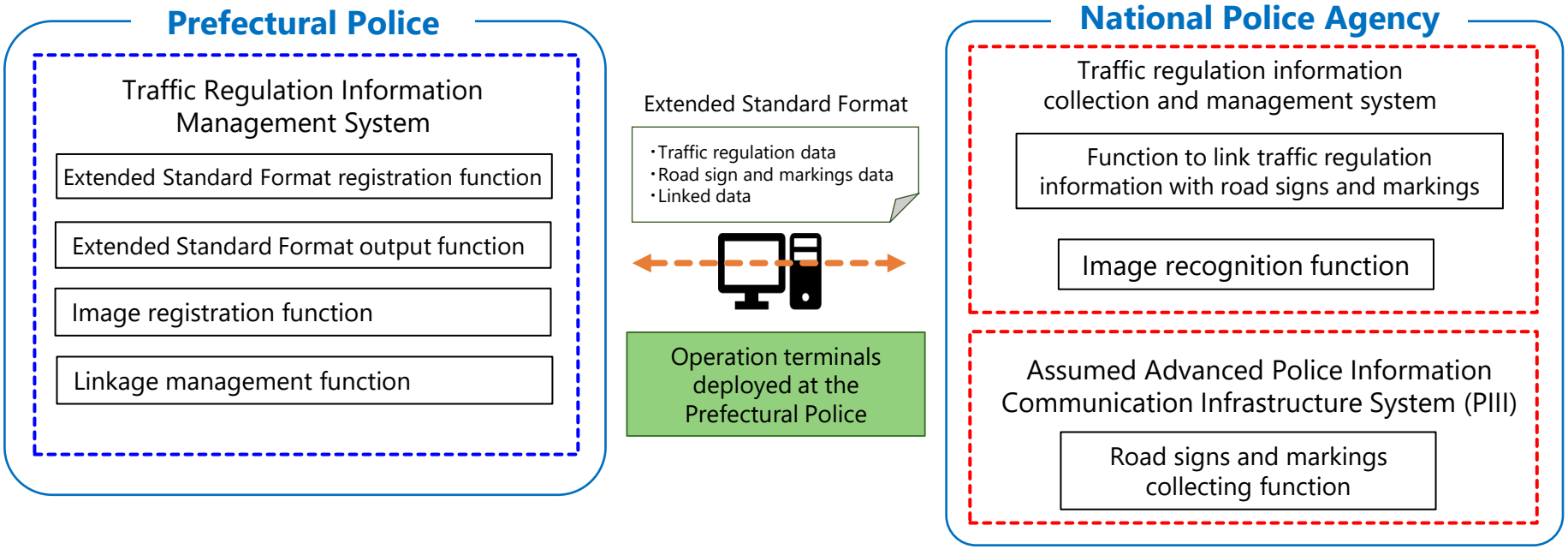
Draft requirement definitions for the National Police Agency and Prefectural Police systems were prepared for functional requirements to be implemented in the National Police Agency and Prefectural Police systems.

【Main Functional Requirements】

National Police Agency System
Traffic regulation information collection and management
Linkage of traffic regulation information to road signs and markings
Road signs and markings collection
Image Recognition

Prefectural Police System
Input/output of Traffic control information in the Extended Standard Format, Signs and markings, and Linkage information.
Map display of Traffic control information in the Extended Standard Format, Signs and markings, and Linkage information.
Change the tentative information to the official information on the digital map and on the Traffic Regulation Information List screen.

【 Prefectural Police System Application Configuration Diagram 】



7. Examination on Integration with High-Precision 3D Maps

- Since a high-precision 3D map is essential for automated driving vehicles, studies were conducted on the feasibility of using traffic regulation information managed by the Prefectural Police on this 3D map for the practical application of automated driving on ordinary roads, based on data from the Makuhari area in Chiba Prefecture.

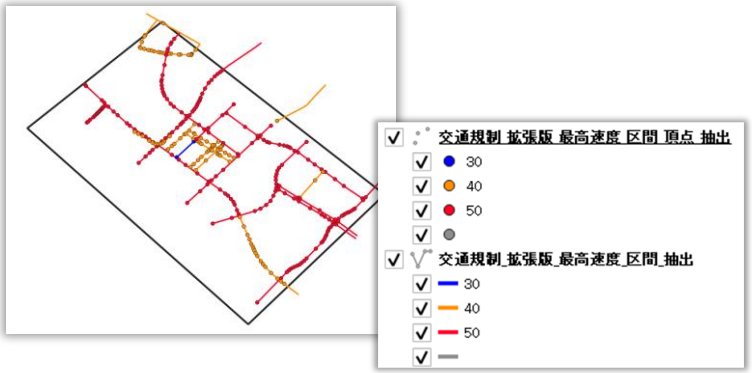
Extraction

- Filtering the regulation type required for high-precision 3D maps and extracting traffic regulation information on the target route from the regulation coordinates.

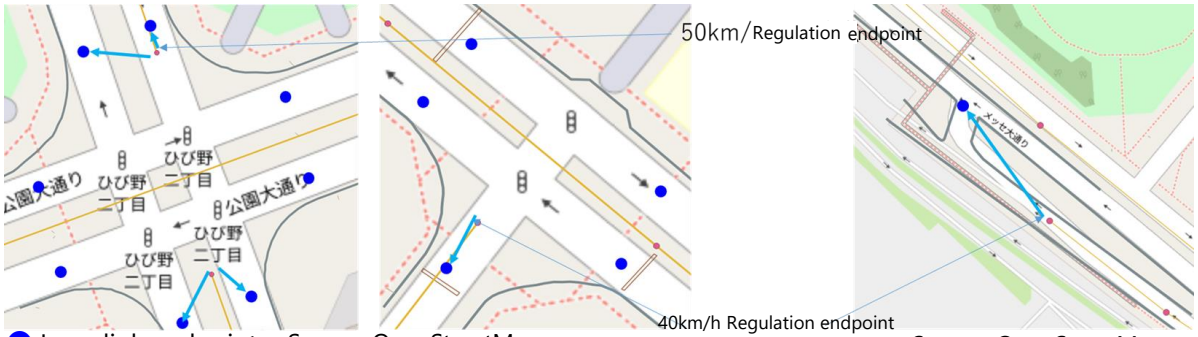
Capturing

- Method to match the extracted traffic control information to the lane link endpoints on a high-precision 3D map

Extraction Result



Alignment of regulatory endpoints to lane link endpoints



● Lane link endpoints Source: OpenStreetMap
→ Regulation alignment

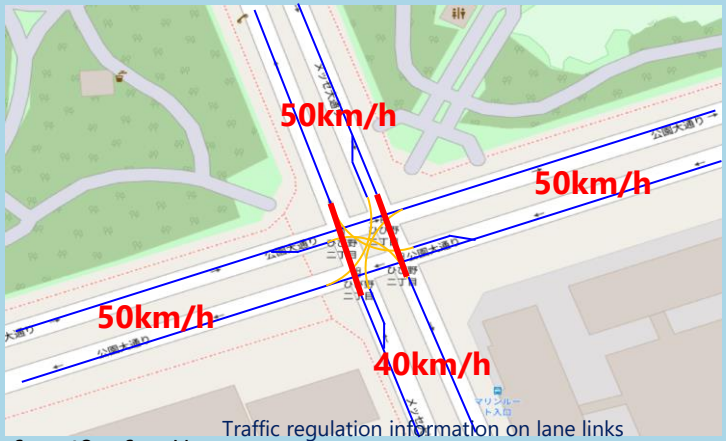
Source：OpenStreetMap

【Results of the Study】

- It was confirmed that it is possible to match the targeted traffic regulation information (speed regulation and temporary stop) by determining the consistency between the coordinate data contained in the regulation information and the lane link endpoint coordinates in the high-precision 3D map with a certain tolerance value.

【Future Tasks】

- The study confirmed that it is necessary to consider how to interpret spaces (within intersections) in traffic regulation information where endpoints are discrete, as shown in the figure on the right, for high-precision 3D maps that require continuity.



Source：OpenStreetMap

Traffic regulation information on lane links
(Blue: Regulation string attached, Red: Regulation indefinite)

8. Considering Priorities for Improving Accuracy

Prioritization of ways to improving the accuracy of traffic regulation information in prefectural police were discussed.

(1) Results of research of SIP (phase1)

- The results of a survey of automobile manufacturers regarding the importance of traffic regulation information by regulation type are shown in the table below.

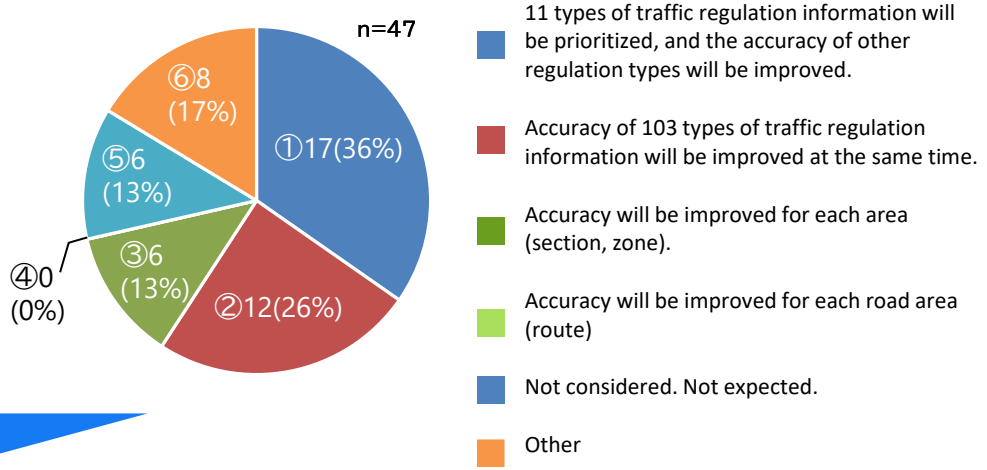
Priority

High	Middle	Low
Types of information on speed and traffic regulations related to braking while driving	Type of information on parking methods and regulations related to restrictions such as no parking, etc.	Type of information related to bicycle riding and pedestrians

(2) Results of questionnaire survey of prefectural police

- Confirmed that there are different ideas of priority
- The most common response was "Prioritize the development of 11 types of regulations and continue to improve the accuracy of other types of regulations."

Q17. Priority Order for Accuracy Improvement



(3) Consideration of priorities for improving accuracy

Based on results above, priorities are considered.

High → Priority → Low

〈Priority 1：11 types of old traffic regulation inforamtion〉
Among traffic regulations related to braking while driving, 11 types of information were available until FY2020.

〈Priority 2：Type of traffic regulation information mainly for bycecle riding〉
Information types (other than 11 types) on traffic regulations and speed restrictions related to braking when driving a vehicle

〈Priority 3：Information on traffic regulations mainly related to parking for vehicles〉
Types of information on regulations related to restrictions such as parking prohibition, parking methods, etc.

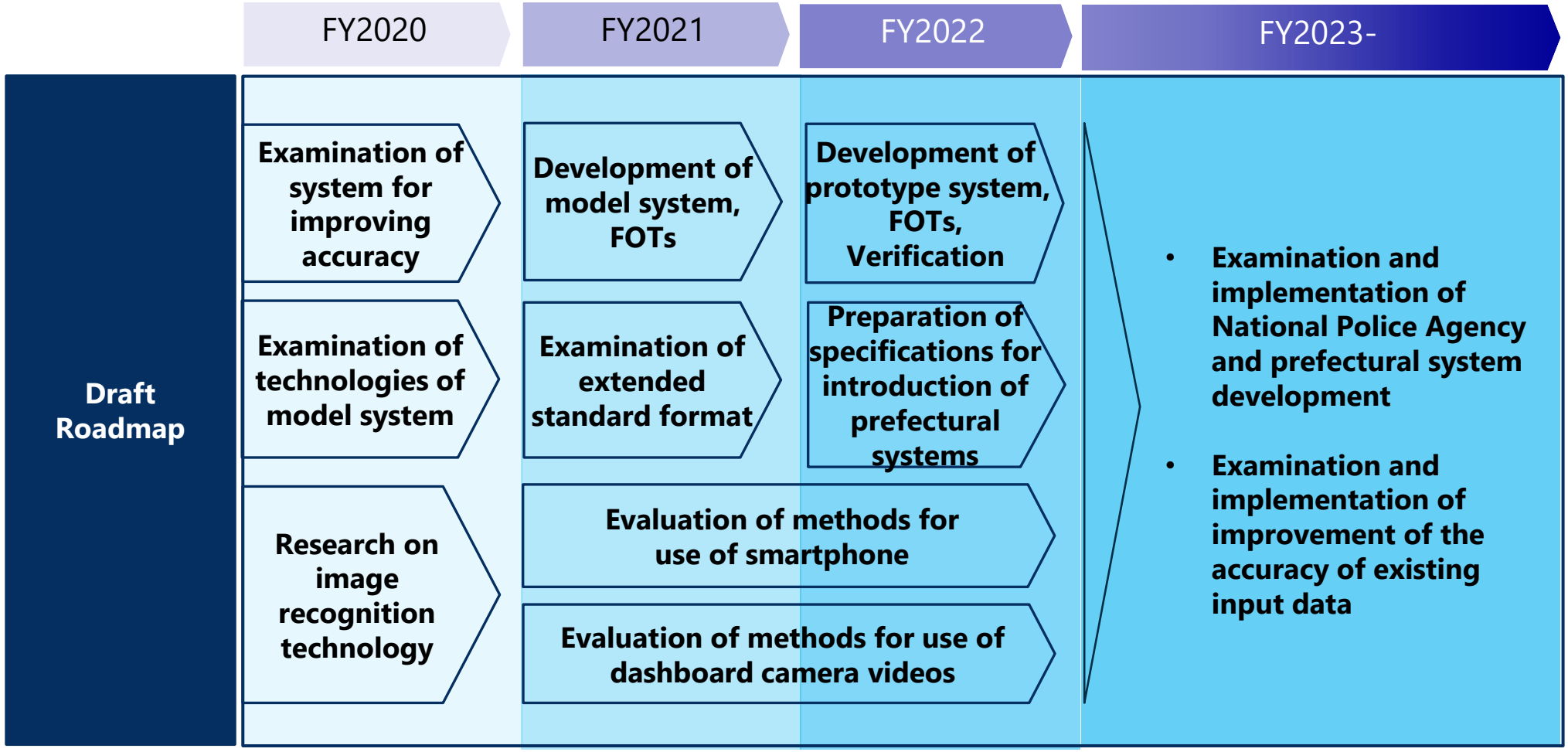
〈Priority 4：Information type of traffic regulation mainly for bicycles and pedestrians〉
Information on traffic regulations related to bicycle riding and pedestrians

8. Considering Priorities for Improving Accuracy

(4) Roadmap for improving the accuracy of traffic regulation information

A roadmap for improving the accuracy of traffic regulation information was created in consideration of (1) through (3).

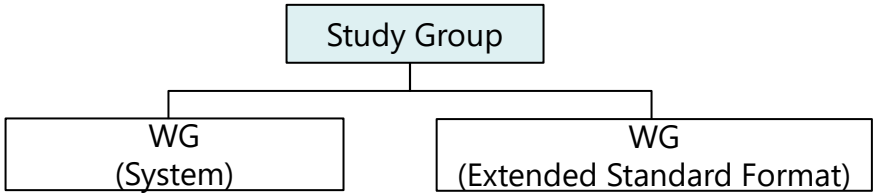
- In FY2022, build a prototype system, conduct FOTs and verification, and prepare specifications for the implementation of the systems for prefectural police.
- From FY2023 onward, the systems for National Police Agency and prefectural police systems will be studied and developed to improve the accuracy of traffic regulation information for prefectural police.



9. Study Group, WG

(1) Study Group (Review Meetings)

- To research improving the accuracy of traffic regulation information data, the "Study Group for Improving the Data Accuracy of Traffic Regulation Information" was established, consisting of experts, authorities related to automated driving, prefectural police, related associations, map companies, and private companies that handle traffic regulation information management systems, and held three meetings each year.
- To accelerate discussions in the study group, two working groups (WGs) were established to build a technical study system.



【Outline of 2021】

No.	Date, Time	Venue	Agenda
1	25/8/2021 13:00-15:00	Web	• Implementation Policy for FY2021 • Future Schedule
2	19/11/2021 14:00-16:00	Web	• Status of model system development (interim report) • Examination of image recognition technology (interim report) • Plan for FOTs (draft) • Prototype system requirement definition (draft) • Examination of extended version standard format (interim report)
3	25/2/2022 14:00-16:00	Web	• FOTs for the model system • Progress of examination of image recognition technology • Status of examination of extended version standard format • Priority to improve accuracy • Items to be examined in FY2022

【Outline of 2022】

No.	Date, Time	Venue	Agenda
1	3/6/2022 14:00-16:00	Web	• Implementation Policy for FY2022 • Future Schedule
2	21/9/2022 14:00-16:00	Web	• Development status and FOTs plan for the prototype system • Status of system operation manual • Progress of study of the Extended Standard Format and manuals • Status of studies related to integration with high-precision 3D maps • Schedule for the future
3	25/1/2023 14:00-16:00	Web	• Results of the FOTs • Draft Requirements Definitions for National Police Agency and Prefectural Government Systems • System Operation Manual; final version • Extended Standard Format Improvement and Explanation Manual; final version • Results of studies related to integration with high-precision 3D maps • Preparation of the report

9. Study Group, WG

(2) WG (System)

- The WG, consisting of the National Police Agency, Prefectural Police, and private companies making traffic regulation information management systems, met once each year.
- In 2021, the WG discussed the specifications of the prototype system, and in 2022, the WG discussed the draft requirement definition and system operation manual for introducing functions into the National Police Agency and Prefectural Police systems.

【Outline of 2021】

No.	Date, Time	Venue	Agenda
1	7/10/2021 10:00-11:30	Web	• Functional requirements for the road sign location prediction system and Survey App • Requirements definition for the 2022 Model System

【Outline of 2022】

No.	Date, Time	Venue	Agenda
1	29/11/2022 13:30-15:00	Web	• Status of examination of draft system requirement definitions for National and Prefectural Police • Status of examination of system operation manuals

(3) WG (Extended standard format)

- The WG, consisting of the National Police Agency, Prefectural Police, related associations, and cartographic companies, met twice each year to resolve issues related to the current standard format.
- The WG members were asked for their opinions on the draft Extended Standard Format and the manual, and issues were sorted out and improvements were made.

【Outline of 2021】

No.	Date, Time	Venue	Agenda
1	14/10/2021 9:30～11:00	Web	• Identification of issues in the current standard format • Sharing of issues from the user side (cartography companies)
2	24/12/2021 13:30-15:30	Web	• Report on the results of the prefectural police questionnaire survey (preliminary results) • Presentation of the review proposal by regulation type • Presentation of the proposed structure of the extended version standard format

【Outline of 2022】

No.	Date, Time	Venue	Agenda
1	27/7/2022 13:30-15:00	Web	• Changes from the Extended Standard Format 2021 edition • Considerations for the Extended Standard Format manual
2	15/11/2022 13:30-15:00	Web	• Status of study of the Extended Standard Format based on the results of the FOTs • Draft Extended Standard Format Manual

10. Summary

❶ Prototype System Results

【Targets Achieved】
- In the FOTs in 2022, we achieved a tentative linkage rate of 95.3% and a correct answer rate of 99.7%, far exceeding the target values (tentative linkage rate of 90% or more and correct answer rate of 95% or more).

【Confirmation of Validity for Improvement of Accuracy】
- The survey application can be used to collect directional information on traffic regulations, which will improve the accuracy of predictions and contribute to the development of directional information data.
- The system was able to detect traffic regulation data that did not originally exist through the road sign and marking location prediction system.

【Reduction of Workload for Prefectural Police】
- The system can efficiently collect information on a wide area of road signs and markings using a dashboard camera and generate a large amount of road sign and markings data almost automatically by utilizing an image recognition system.

【Response to Social Implementation】
- The system was confirmed to apply to different prefectures with different operational methods by adjusting parameters such as the prediction range and sizes.

【Application and Development for Police Work】
- The images of road signs and markings collected by the Survey App and the Image Recognition System can be used for daily inspection work and survey and renewal planning.

❷ Extended Standard Format and Manuals Results

【Solutions to Current Format Issues】
- The Extended Standard Format has been reorganized into items with clarified definitions to deal with differential updates and to improve the accuracy of data content, in response to structural issues and lack of input definitions.

【Promoting Understanding of Registrants and Users】
- The definitions of the Extended Standard Format were compiled into manuals that can be understood by Prefectural Police and data users, and specific registration examples were provided for each regulation type to ensure common understanding of the format.

❸ Results for integration with high-precision 3D maps

【Possibility of Utilization on 3D Maps】
- It was confirmed that traffic regulation information can be integrated into high-precision 3D maps based on the location information of traffic regulation data by using a certain tolerance value.

【Conclusion】

The prototype system developed in this study detects misregistration of traffic regulation information by matching information with road signs and markings. It was confirmed that the system works to improve accuracy while reducing the burden on Prefectural Police. In addition to automated driving, the improved traffic regulation information is expected to be used for other police work, such as accident analysis, and to be utilized by both the public and private sectors, for example, by transportation companies to study driving routes. Therefore, it is desirable to continue cooperation among the parties concerned and to study utilization methods for society as a whole.

This report documents the results of Cross-ministerial Strategic Innovation Promotion Program (SIP) 2nd Phase, Automated Driving for Universal Services (SIP-adus, NEDO management number: JPNP18012) that was implemented by the Cabinet Office and was served by the New Energy and Industrial Technology Development Organization (NEDO) as a secretariat.