SIP 戦略的イノベーション創造プログラム
Cross-ministerial Strategic Innovation Promotion Program

Cross-ministerial Strategic Innovation Promotion Program(SIP) 3rD Phase/ Establishment of smart mobility platform / 「Realization of Shared Space through Digital Smart Mobility 」 (II. Research and Development for Redesigning Infrastructure to Support Mobility Services

March 2024

Tsukuba Smart City Consortium
University of Tsukuba(Lead organization)
Tokio Marine & Nichido Fire Insurance Co.,Ltd.
NIPPON KOEI
NEC Corporation
KDDI CORPORATION
Mitsubishi Electric Corporation

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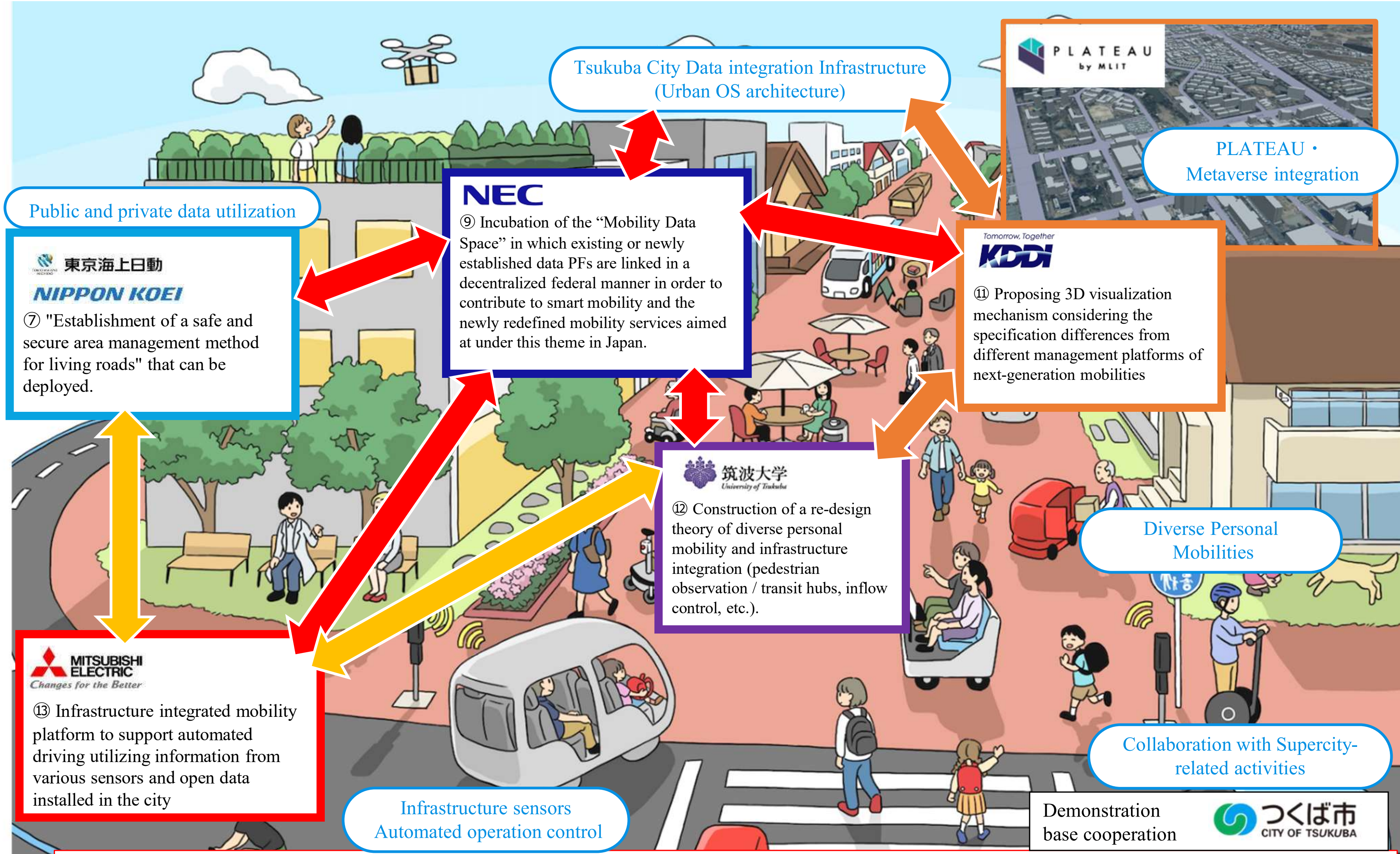
SIP

Realization of Shared Space through Digital Smart Mobility

Partners:
University of Tsukuba (Lead organization),
Tokio Marine & Nichido Fire Insurance,
NIHON KOEI, NEC,
KDDI and Mitsubishi Electric



Shared Space Utilizing Personal Mobility-Centric Cyber-Physical Environment"

Realizing safer roads by minimizing traffic rules to facilitate mutual yielding among vehicles, pedestrians, and other traffic entities.

1. ⑦ Establishment of a safe and secure area management method for living roads“ that can be deployed.

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⑦Establishment of a safe and secure area management method for living roads" that can be deployed. (⑦-1、⑦-4)

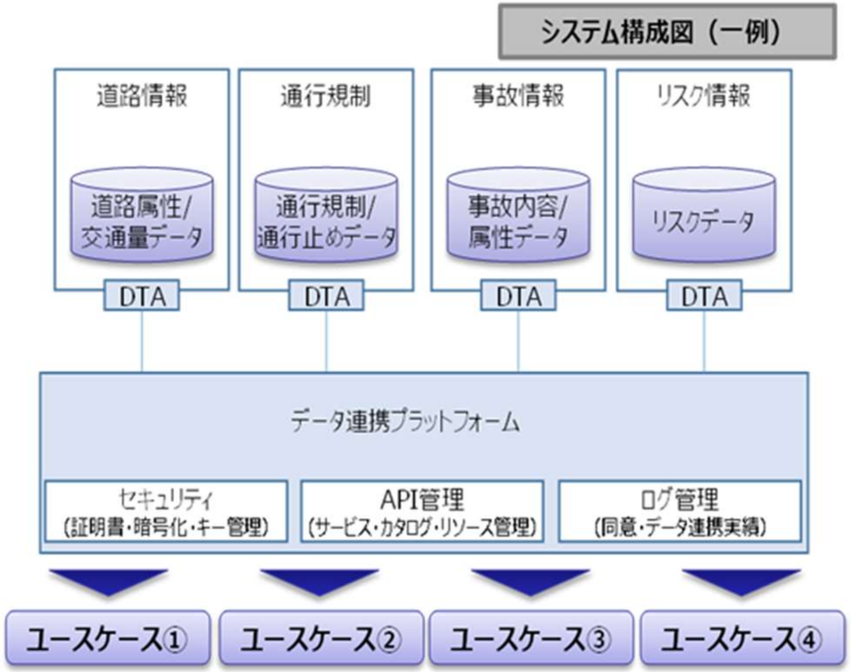
Tokio Marine & Nichido Fire Insurance Co., Ltd. (subcontracting：Tokio Marine dR Co., Ltd.）、Nippon Koei Co., Ltd.

◆ Realization Targets

- Establishment of a “safe and secure area management method for living roads” that can be expanded horizontally.

◆ Overview of Research and Development

- Organize the characteristics and issues of a wide variety of public and private road traffic data, including Accident-related data held by Tokio Marine & Nichido Fire Insurance Co., Ltd., and examine use cases for identifying and visualizing traffic accident risk factors and monitoring indicators by utilizing and linking such data.
- Through the development of use cases, organize the data to be utilized and its format, and organize the information and rules necessary for platform construction, as well as a monitoring system utilizing the constructed data platform.
- In the Tsukuba area, in collaboration with the consortium and Tsukuba City, etc., implement the PDCA cycle in an integrated manner, including the utilization of the data platform, implementation of measures based on analysis results (social experiments), evaluation of measures (verification of accident reduction effects), and verification of their feasibility.
- Using the Tsukuba area as a model for the demonstration site, we will study scenarios for specific accident prevention measures, focusing on street network configuration planning and travel speed regulations in the existing urban area.



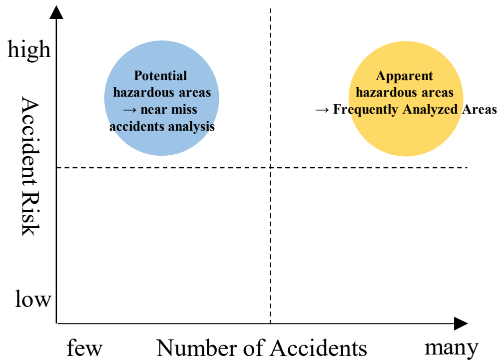
⑦Establishment of a safe and secure area management method for living roads" that can be deployed. (⑦-1、⑦-4)

～Use cases of traffic accident risk to be considered in this project～

Approaches to Traffic Accident Risk

- A quantitative visualization of hazardous areas in a specific region can be achieved by displaying risk values for each road. These risk values are calculated by analyzing accidents and their background data using AI.
- Analyze traffic accident risk contribution of dynamic data by condition (e.g., vehicle traffic volume by time of day, travel speed, hazardous driving by weather, etc.)
- By capturing the increase or decrease in the risk of traffic accidents due to the fulfillment of specific conditions, risk control through more dynamic traffic accident countermeasures can be studied.
  ex.) Dynamic speed restrictions when combined with specific areas, nighttime, and rain

Example of use cases (current status)

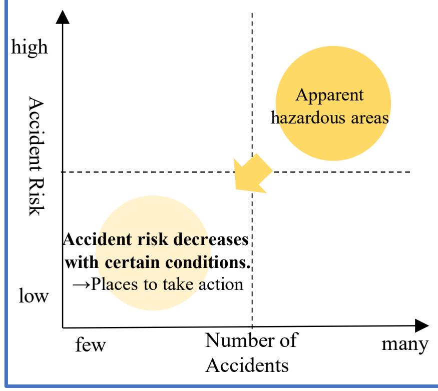


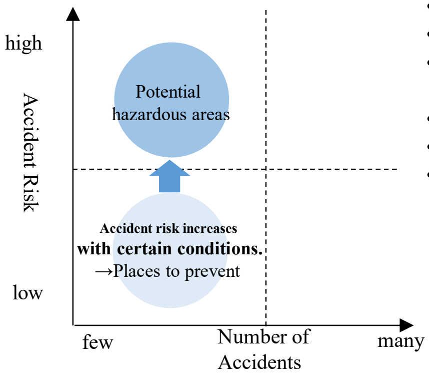
Dynamic Data
- Vehicle traffic
- Travel speed
- Percentage of sudden movements
- Weather
- Pedestrian traffic volume, etc.

Static data
- Road structure
- Intersection geometry
- Regulatory information (speed limit), etc.

Examples of use cases (considered in this project)

Where accident risk changes as conditions change



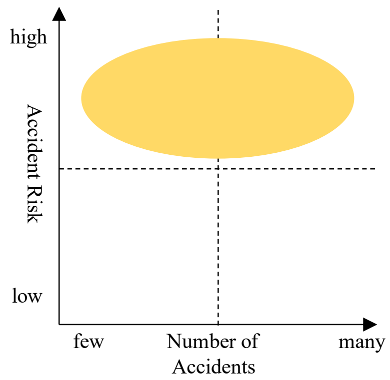


Dynamic Data
- Vehicle traffic
- Travel speed
- Percentage of sudden movements
- Weather
- Pedestrian traffic volume
- ・・・・

→How accident risk changes when the time of day and other conditions of these data are changed.

→ Verification of risk control through dynamic measures, etc.

Where accident risk doesn't change as conditions change



Static Data
- Road structure
- Intersection geometry
- Regulatory information (speed limit)
- ・・・・

→Drastic measures are needed where the accident risk is high even if dynamic data is changed.

⑦Establishment of a safe and secure area management method for living roads" that can be deployed. (⑦-1、⑦-4)

〜Data organization and precedent case studies on data held by the public and private sectors〜

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Data organization and precedent cases study on data held by the public and private sectors

- In order to organize use cases for the utilization of data on accident risk, indicators for evaluating safe and secure were organized. In addition, data items used in previous studies were organized.
- It was confirmed that both foreign and domestic data related to road structure and traffic volume are abundant, as in previous accident analyses, and that studies on dynamic traffic accident risk have been conducted in existing studies in Japan.
- It was confirmed that if data related to living roads could be added and detailed, and if indicators related to liveliness as well as safe and secure could be added, it would be possible to calculate accident risks toward the future vision that should be aimed for.

Previous studies, examples of initiatives (overseas cases)

Example	Database of accident in Europe (EU)	Database of accident data, studies, etc. in the U.S.	World Road Association
Overview	Operated by the European Commission Dashboard management of accidents in each EU country	Operated by Federal Highway Administration Data on accidents, road conditions, traffic volume, etc. available for each state	Policy for analyzing various types of data such as accident data, etc.
Contents of data provided	Accident data for EU countries for 2010-2022 Number of fatalities by road type, age group, gender, mode of transportation, etc.	Accident information, road structure, traffic volume, etc.	-
URL	https://dashboard.tech.ec.europa.eu/qs_digit_dashboard_mt/public/extensions/MOVE_CARE_public/MOVE_CARE_public.html	https://highways.dot.gov/research/safety/hsis/safety-analysis-tools	https://roadsafety.piarc.org/en/road-safety-management-safety-data/integrating-data

Explanatory variables for risk values associated with each previous study

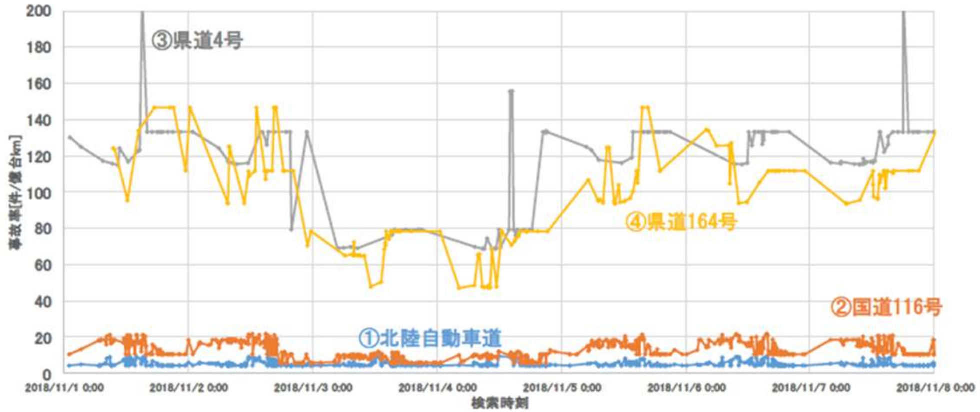
- Organization of information on accident risk from 11 latest Infrastructure Planning and Management conference papers and other sources.
- Road structure, traffic volume, vehicle speed, etc. are often utilized as explanatory variables for accident risk, but there is no utilization of the number of pedestrians by attribute, etc., which can be determined from the human flow data.

Organization of studies examining accident risk on living roads.

- In the traffic safety management using accident risk information by Katsumura et al. of Ehime University, the issue was mentioned that the constant issuing of warnings may lead to a loss of trust by drivers and **the fear that no one will be alerted when a truly dangerous situation emerges**.⇒**Dynamic Traffic Accident Countermeasures**

Previous studies on dynamic traffic accident risk calculation

- Professor Yoshii of Ehime University conducted research on dynamic risk in the research and development of traffic accident risk management methods.
- **Predicts accident risk and calculates dynamic changing accident risk** from multiple factors in a description regarding a route guidance system to a road with low accident risk.



出典 新道路技術会議 道路政策の質の向上に資する技術研究開発 成果報告レポート No.29-5「交通事故リスクマネジメント手法の研究開発」

⑦Establishment of a safe and secure area management method for living roads" that can be deployed. (⑦-1、⑦-4)

〜Hearings with leading municipalities/Hearings for the utilization of government data〜

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Municipal Needs for Living Roads Measures

- Conducted interviews in February 2024 with municipalities promoting measures for living roads using big data, etc.
- The locations where safety measures are to be implemented are determined based on information confirmed at the site and local requests, and it takes time to select the locations and reach a consensus.
- When selecting locations where potential accident risks need to be addressed, the decision is not based on data: "Is that really a dangerous place, or is there no dangerous place although there is no request from the residents?
- A map that shows the accident risk for the entire region can be used to select the areas for countermeasures. If the effects of countermeasures can be predicted, the time required to reach consensus can be shortened, and the number of sites where countermeasures can be implemented in a single year can be increased.

Hearing items	Answer
Reasons and background of selection of areas to be considered for countermeasures	• The first area was provided data by the Ministry of Land, Infrastructure, Transport and Tourism. Other areas are local requests, approaches from the government side, etc. • **Ultimately, the elementary schools will select the areas that they are told need to be addressed.** We select areas where the school can help, as hardware measures alone are not effective.
Approach to identifying traffic hazard areas	• Due to the volume of data for the entire city area, **it was difficult to identify potential hazardous locations, so the approach was based on the number of accidents.** • We select an area focused on the occurrence of accidents on roads less than 5.5m wide and request the analysis results of ETC2.0 data from the Ministry of Land, Infrastructure, Transport and Tourism. • Local requests, traffic control information (confirmed by police or on-site inspection), road grades (confirmed on-site), etc. will be obtained by the municipalities.
Issues and needs for living roads measures	• **There are no tools to identify areas where countermeasures against potential risks can be studied from a preventive maintenance perspective.** This is where time and money are spent. • In addition, it is difficult to reach a consensus with residents when considering the implementation of preventive maintenance measures. • Monitoring after implementation of countermeasures has not been conducted except for "travel speed".
Data to be used for accident measure studies	• It would be easier to consider if there is data available to see the road structure (roadside strip, colorization, slope, etc.). Currently they are confirmed on site. • **It would be good if the risks could be seen on heat maps, etc.,** so that areas to be addressed can be selected. **Consensus building will be easier.** • If the time for district selection can be shortened, **we can increase the number of areas to consider one more district measure.**
Does the sophistication of risk analysis lead to sophistication of accident countermeasures?	• We want to streamline the time-consuming process of selecting locations for countermeasure studies. • It is easier to promote consensus building **if the menu of countermeasures and the effects of implementing the countermeasures can be seen in advance** in line with the actual risk situation. • **If the effectiveness of countermeasures can be monitored,** it can be used for the next countermeasure study, thus increasing the number of areas where countermeasures can be implemented in a single year.

Administrative Collaboration for Utilization of Government Data

- Consultation with the National Police Agency and the Ministry of Land, Infrastructure, Transport and Tourism regarding the content of data held by the government and whether or not it can be provided, in order to utilize traffic-related data held by the government.
- Government data will also be used when planning and formulating social experiments in the Tsukuba area in the next fiscal year.

⑦Establishment of a safe and secure area management method for living roads" that can be deployed. (⑦-1、⑦-4)

~ Use Case Study (Traffic Accident Risk Analysis in Tsukuba Area) ～

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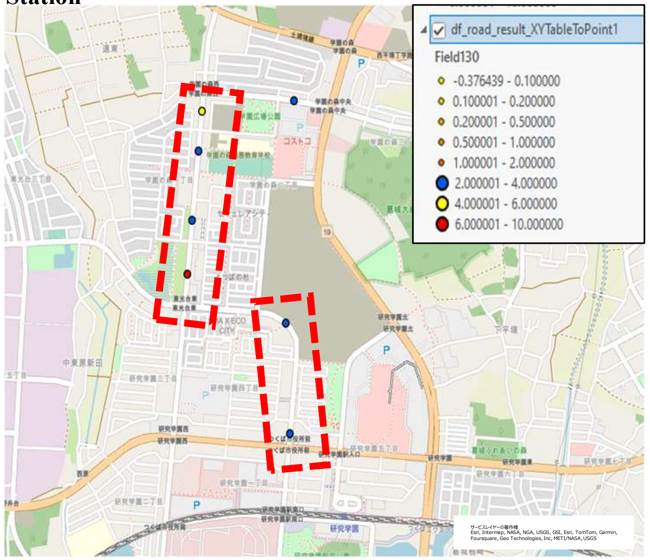
- **Traffic Accident Risk Analysis and Consideration of Dynamic Factors and Measures**
  - By combining accident data from Tokio Marine with external data and utilizing AI, the risk analysis of the Tsukuba area has been conducted.
  - Moving forward, the focus will be on analyzing dynamic and external factors around high-risk locations, examining data that can capture fluctuating accident risks, and considering measures to reduce accident risk.

AI-driven traffic accident risk analysis

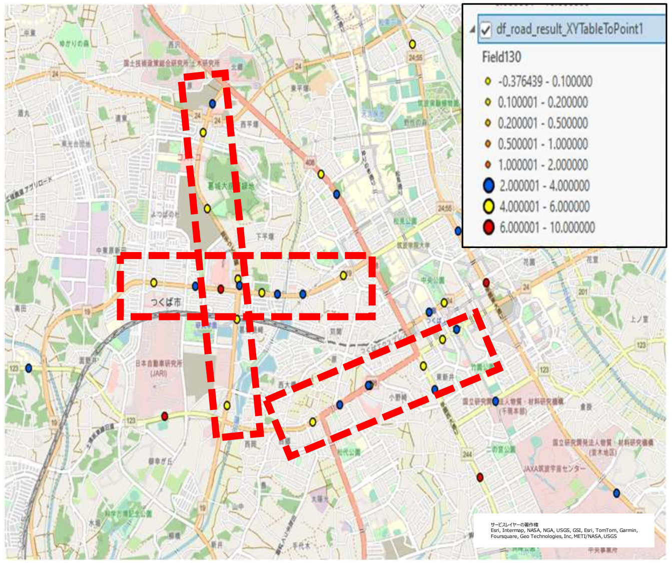
By training AI with accident data from Tokio Marine, dashcam footage, and background data (examples below), we can predict the risk value (number of traffic accidents) for each road and intersection.

- Road information (number of lanes, road width, presence of traffic signals,, etc.)
- Traffic volume, human flow
- Accident background information (time of day, weather, etc.)
- Information on nearby commercial and other buildings.

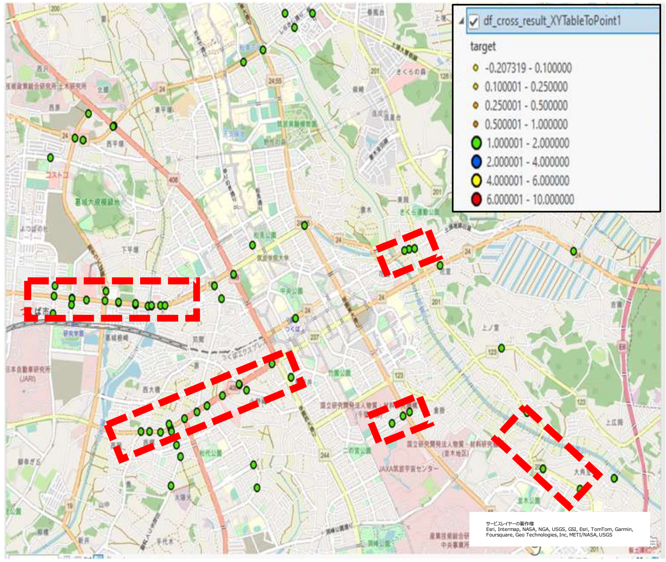
[Example 1] Main roads(high risk): Around Kenkyu-gakuen Station



[Example 2] Main roads(high risk): Around Tsukuba Station



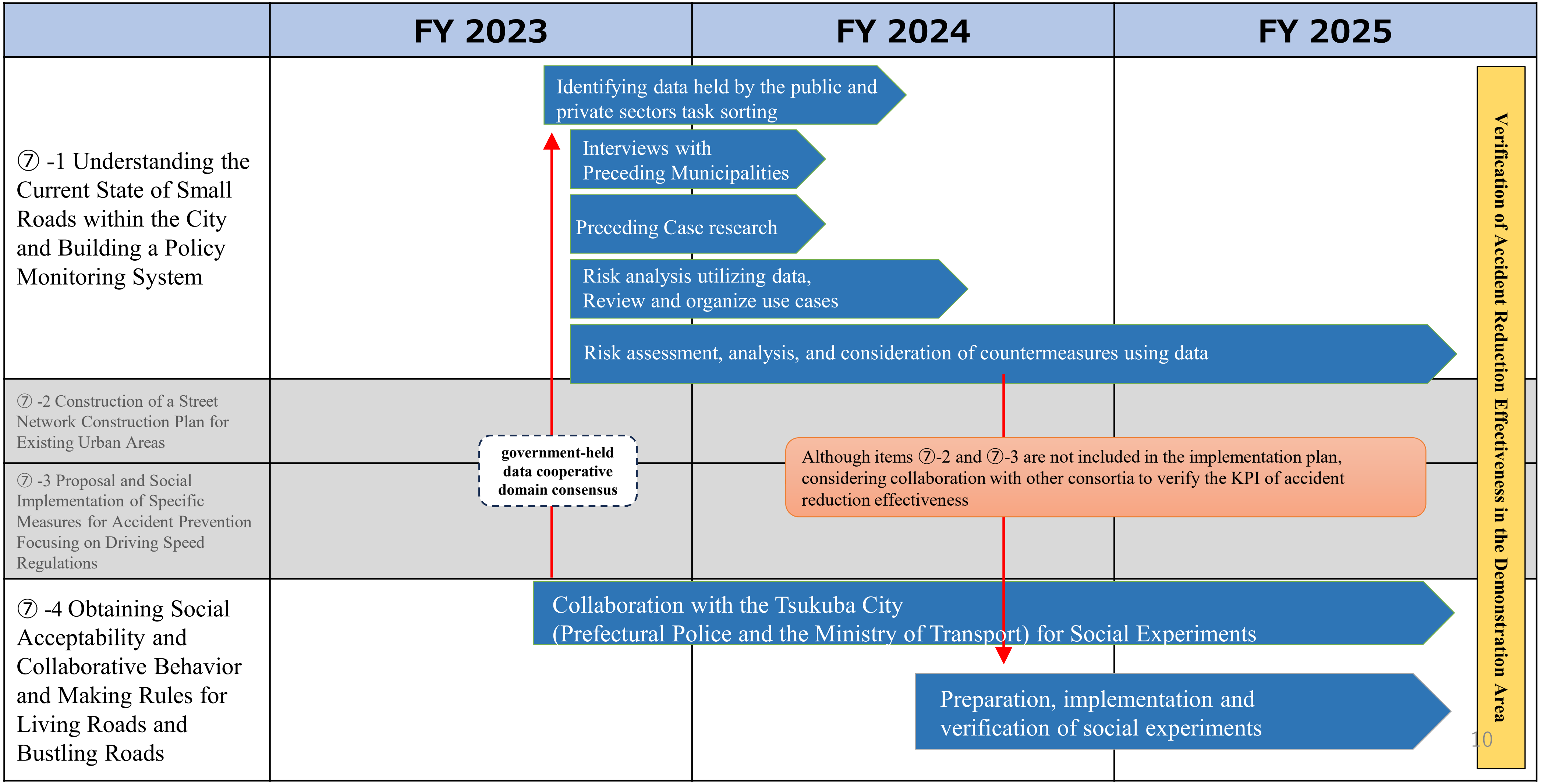
[Example 3] Intersection(high risk): Around Tsukuba Station



*Know-how on AI-driven traffic accident risk analysis even before the start of SIP

⑦Establishment of a safe and secure area management method for living roads" that can be deployed. (⑦-1、⑦-4)

~ Next Steps ~



Deliverables

- Results of Preceding Case Study on Public and Private Data
- Data organization and precedent cases study on data held by the public and private sectors
- Results of Interviews with Preceding Municipalities Implementing Traffic Safety Measures Utilizing Big Data
- Results of Traffic Accident Risk Analysis Using AI in the Tsukuba Area

NEC

2. ⑨ Establishment and demonstration of an infrastructure for integration and mutual use of various mobility platforms and related data.

Tsukuba Smart City Consortium
NEC Corporation

⑨ Establishment and demonstration of an infrastructure for integration and mutual use of various mobility platforms and related data

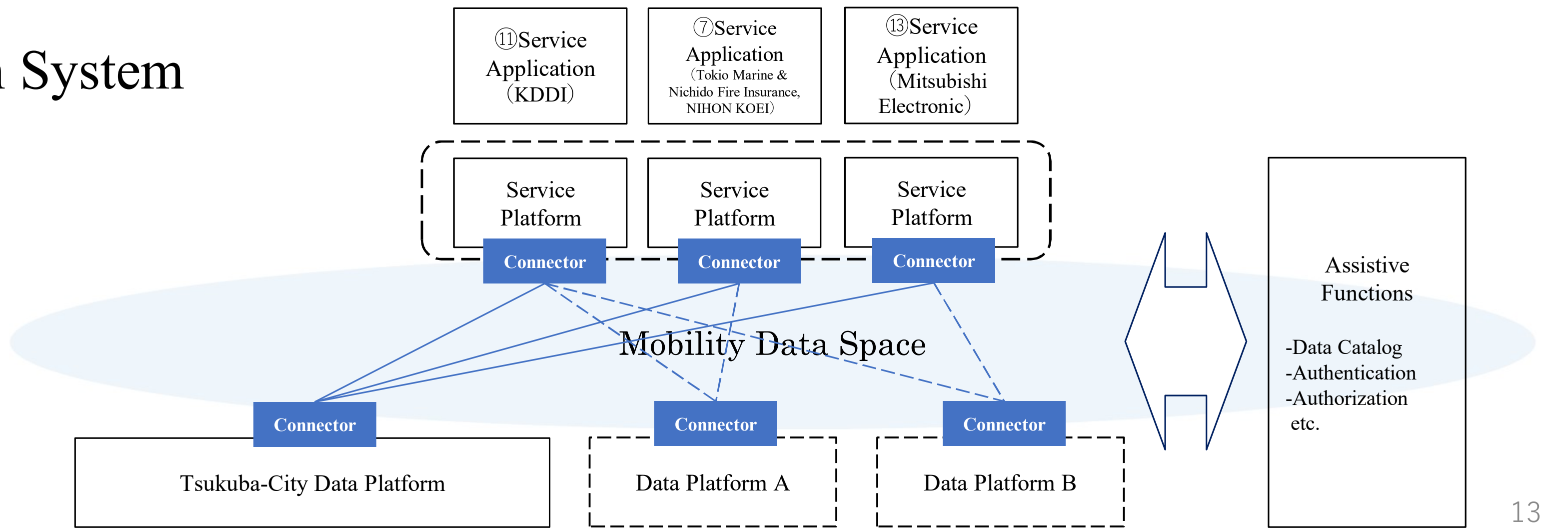
■Overview

- ■ This study aims to do just that is incubation for social implementation of "Mobility Data Space" (technical specification studies, demonstrations, etc.)
- ■ Specifically, we will verify mobility services through demonstrations by Tsukuba Consortium co-implementers, formulate technical specifications (frameworks) for mobility and data spaces, and consider social implementation (organization, structure, etc.).

■Purpose

- ■ As a role model, we aim to implement it through the demonstration of mobility data space in the Tsukuba-City area.

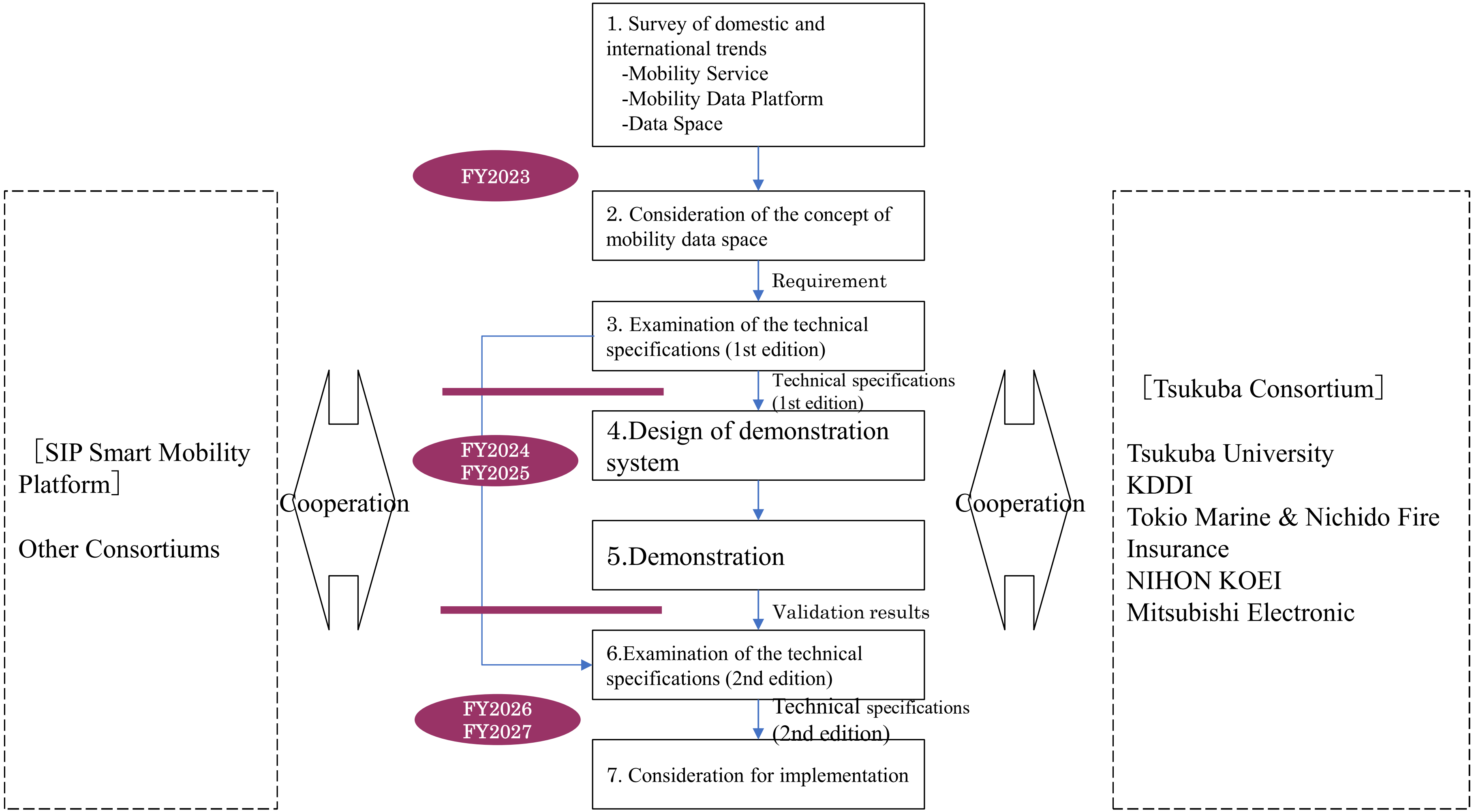
■Overview of the Demonstration System



⑨ Establishment and demonstration of an infrastructure for integration and mutual use of various mobility platforms and related data

NEC

■Specific details and schedule



⑨ Establishment and demonstration of an infrastructure for integration and mutual use of various mobility platforms and related data

NEC

■Achievements in FY2023

- ■ Survey of domestic and international trends
  We first conducted a desk survey on use cases related to smart mobility services, data platforms, and examples of domestic and international initiatives related to existing data space to grasp the current situation in building mobility data space. Next, we identified data space that are highly relevant to the efforts of SIP and the consortium, then conducted an in-depth survey by interviewing related businesses. Based on the results of these surveys, we have identified the requirements for mobility data space.
- ■ Consideration of the concept of mobility data space
  Based on the results of the "Survey of domestic and international trends", we examined the appropriate configuration of a "Mobility Data Space" for Japan, which would serve as the requirements for the technical specifications (1st edition).
- ■ Examination of the technical specifications (1st edition)
  Based on the results of the "Consideration of the configuration as “Mobility Data Space", we examined the core technical specifications for realizing “Mobility Data Space”.
  Finally, we defined an API specification for the services of “Mobility Data Space”.

⑨ Establishment and demonstration of an infrastructure for integration and mutual use of various mobility platforms and related data

NEC

Deliverable

- The technical specifications for Mobility Data Space (1st edition)

3. ⑪ Development of mobility-enabled services on urban OS

Tsukuba Smart City Consortium
KDDI CORPORATION

Building a system to visualize simulations of next-generation mobility (self-driving cars, drones) in 3D space. Contribute to the consideration of smart city services that utilize next-generation mobility by various businesses and local governments.

Research and development overview

3D simulation of next generation mobility
(self-driving cars, drones)
We will build a system to visualize in space.

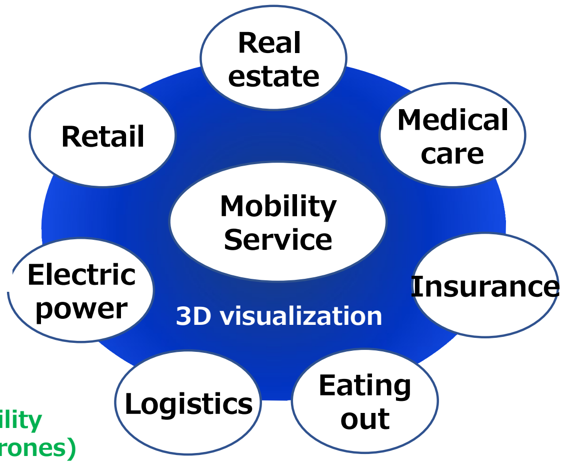
What we want to achieve

We will create an environment where businesses and local governments can utilize the results of this research and development (3D visualization) to consider services that link mobility to diverse industries such as real estate and medical care.

3D visualization

Cooperative control function

next generation mobility (Autonomous driving, drones)



An image of what we want to achieve

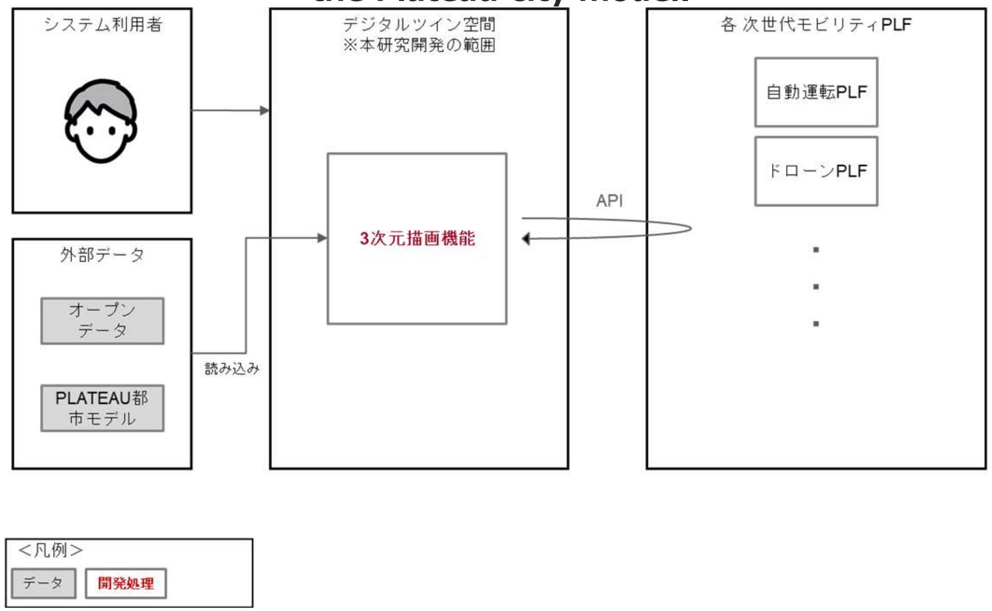
	Collaboration proposal
Real Estate	Mobility simulation during construction of condominiums and commercial facilities
Medical care	Simulation for transporting medical supplies and autonomous driving of future ambulances
Insurance	Accident situation reproduction simulation combining video data, etc.
Eating out	Automatic food and beverage delivery simulation using next-generation mobility collaboration
Logistics	Simulation of core transportation, on-site transportation, etc.
Electric power	Simulation of VPP etc. using EV self-driving buses etc.
Retail	Automatic EC delivery simulation using next-generation mobility collaboration

Tomorrow, Together KDDI

Information on the overall architecture and asset model to be visualized is shown below.

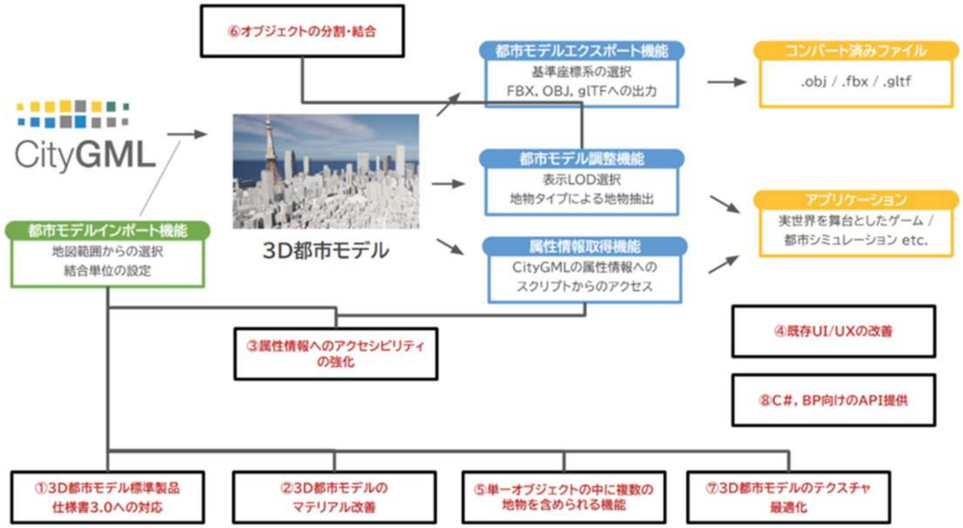
overall architecture

Based on the already developed next-generation mobility PF, we have built a function to perform 3D visualization based on this information. Assumes efforts using external data such as the Plateau city model.



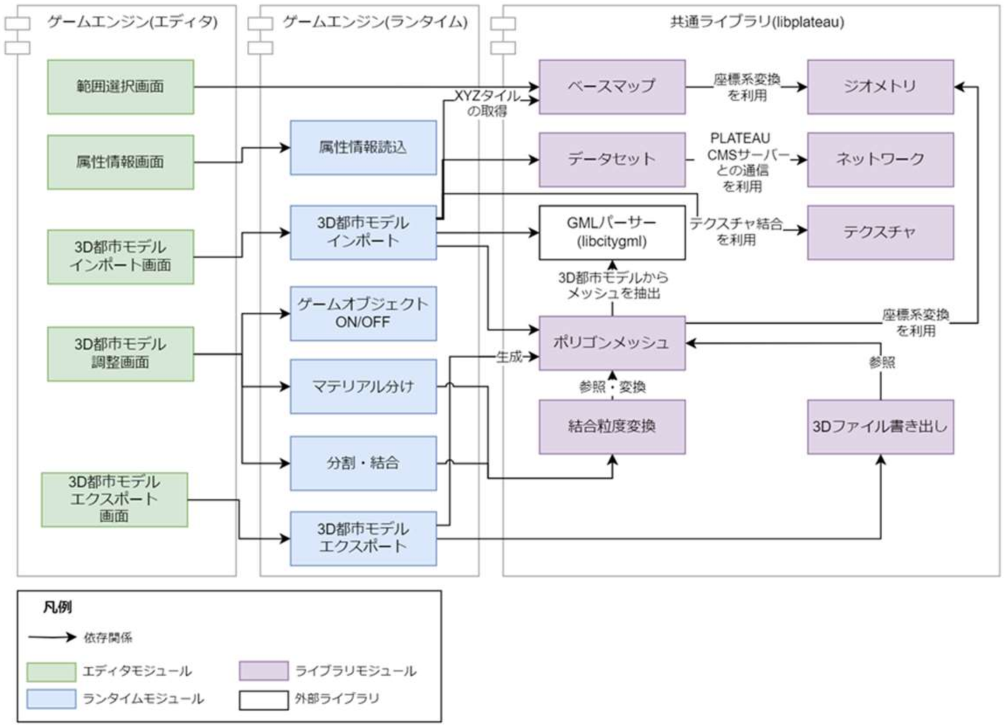
Visualization asset model

Information on the asset model to be visualized is shown below.



The architecture of the visualization part is shown below.

Visualization part architecture



筑波大学
University of Tsukuba

4. ⑫ Extraction of requirements for vehicles, infrastructure that contribute to re-design

Tsukuba Smart City Consortium
University of Tsukuba

⑫Requirements elicitation for personal mobility and infrastructure for mobility re-design

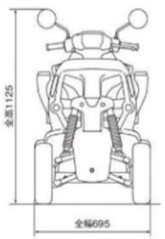
筑波大学 University of Tsukuba

Purpose of R&D：
To realize a prototype vehicle that aligns with a new multimodal transportation service centered around the utilization of personal mobility (including electric wheelchairs, autonomous personal mobility, and unmanned transport robots) and to construct it as a problem-solving model for highly automobile-dependent rural cities.

General Plan:
1. Requirements elicitation of diverse personal mobility and infrastructure for mobility re-design.
2. Establishment of the mobility re-design theory including road shoulders, transfer points, and inflow control.
3. Requirements elicitation of value-added services such as the moving human body observation.
(Pedestrian facial expressions and walking behavior)

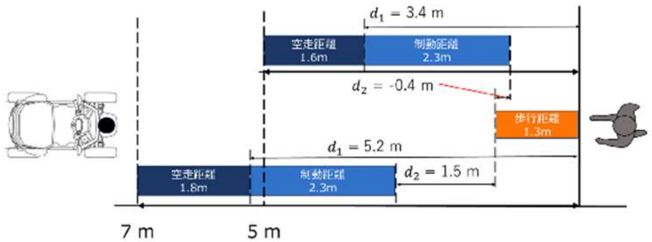
1) Challenge of the Maximum Speed of the Vehicle for People with Disabilities.

・The target maximum speed of 10 km/h was discussed with the police agency. A study will be conducted to examine pedestrian behavior towards mobility and the psychological impact on pedestrians.



YAMAHA

The braking control system utilizing LiDAR/GNSS was integrated into YAMAHA vehicles and evaluated at JARI.



The adoption of a braking control system to limit the maximum speed. Stop within 1meter on a flat road.

Implementation of brake control and safety verification.

2) Requirements Elicitation of Diverse Personal Mobility and Infrastructure for Mobility Re-design.

・Requirements were extracted from multiple mobility demonstrations conducted in Tsukuba city

Transport Robot Demonstration
Support for commuting and assistance with garbage disposal for the elderly

Ride-Sharing Service
(Demonstration of integration of different mobilities using beacons)

Medical Sample Transportation Support

Mobility demonstration for requirements extraction.

⑫Extraction of requirements for vehicles, infrastructure that contribute to re-design

Deliverable

- Test report “ Basic Evaluation of Maneuverability of Electric Wheelchair”

5. ⑬ Social systemization of automated driving（Safe and secure mobility operations）

Tsukuba Smart City Consortium
Mitsubishi Electric Corporation

⑬ Social systemization of automated driving（Safe and secure mobility operations）

Mitsubishi Electric Corporation

In order to realize safe and secure operation of small mobility on the living and bustling roads, we aim to build up infrastructure-integrated mobility platform to support autonomous driving by utilizing various information collected from not only sensors installed in the mobility but also roadside sensors and open data installed in cities, as shown in Fig. 1.

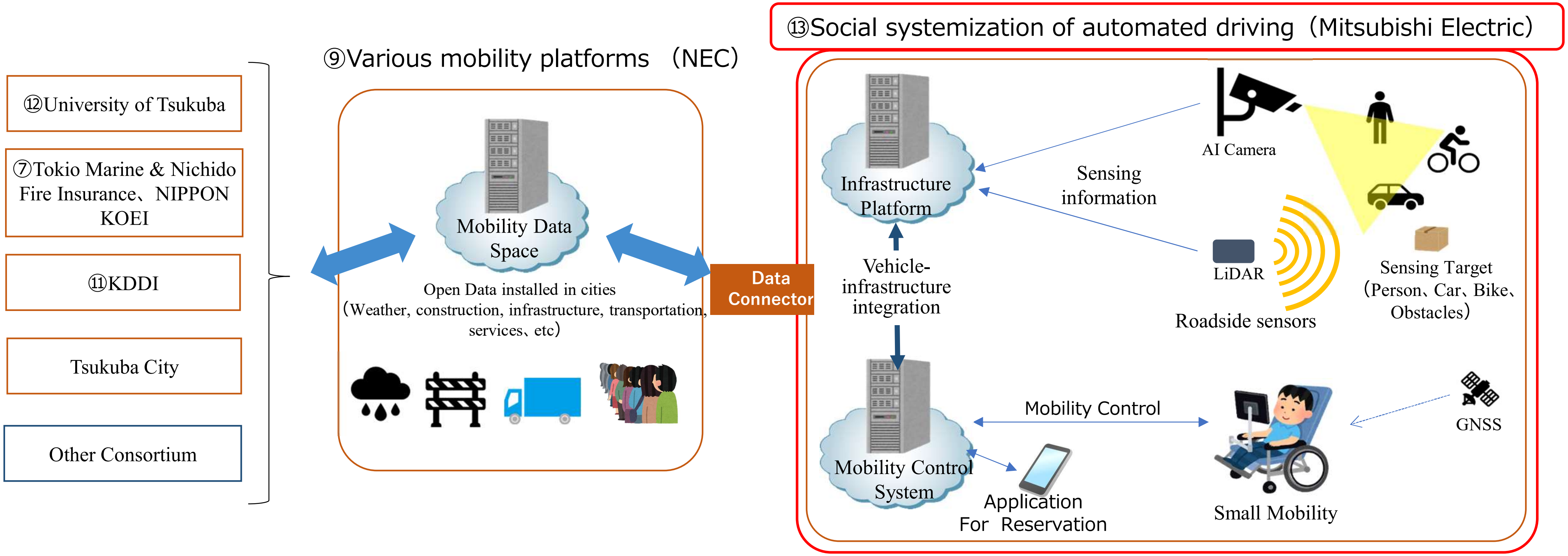


Fig. 1 Infrastructure-integrated Mobility Platform

⑬ Social systemization of automated driving（Safe and secure mobility operations）

In FY2023, we defined the requirements for ”Development of autonomous driving as a social system”. Defined items and outlines are as follows.

(1) Vehicle-infrastructure integrating method in autonomous driving system of small mobility

We determined the requirements for following items of vehicle-infrastructure integration:

a. Policy of data sharing with external system
b. Source and granularity of data needed for vehicle-infrastructure integration
c. Priority between vehicle sensor and roadside sensor
d. Data protocol of vehicle-infrastructure integration (considering future standardization)

Definitions were determined from viewpoints of accuracy, responsiveness, technical practicability, etc.

(2) Vehicle-infrastructure integrating method in autonomous driving system of small mobility

We defined a framework and requirements for estimation of risk by a mixture of various information as shown in Fig. 2.

a. Mobility status information collected from vehicle sensor and roadside sensor.
b. Surrounding information collected from "Mobility Data Space".

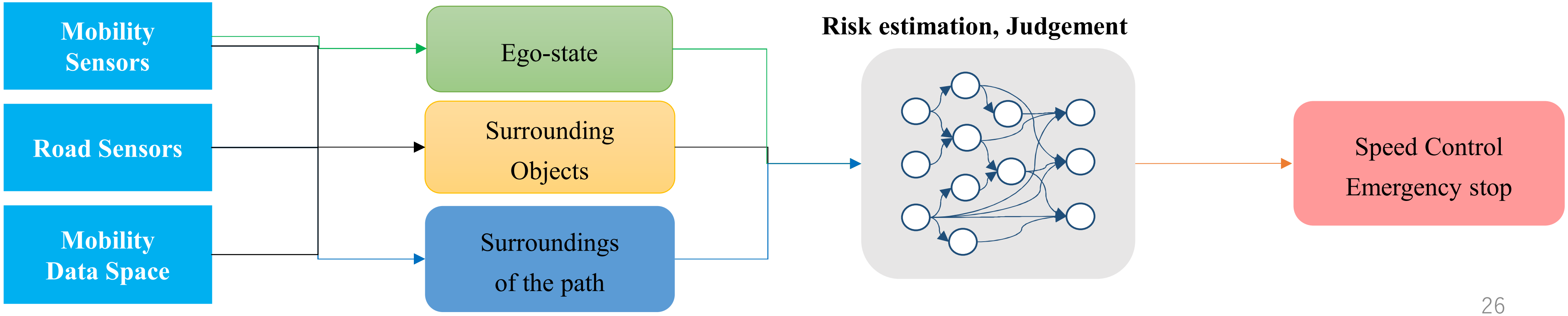


Fig. 2　Risk Estimation Technology Framework

⑬ Social systemization of automated driving（Safe and secure mobility operations）

MITSUBISHI ELECTRIC
Changes for the Better

(3) Sensor configuration and control functions of small mobility vehicles (trial production of prototype chassis)

Based on currently existing vehicles, in order to be able to run at over 6 km/h (current legal speed), we have manufactured prototype chassis equipped with improved wheels, motor, jigs for installation of sensors, as shown in Fig.3.

Fig. 3 Trial production of prototype chassis

(4) Movement range restricting function for small mobility vehicles

In order to ensure safety by setting the range of movement digitally, we defined following procedures:

1. Set restricted (no-driving) areas on the map
2. Estimation of vehicle position by utilizing satellite positioning system and vehicle sensor
3. Detection of entry into a restricted area by laying vehicle position information to the map

(5) Collaboration policy with “Mobility Data Space”

We extracted and organized the data that could be obtained by our system, and considered the significance of providing the data to “Mobility Data Space”.

This paper includes the results of Cross-ministerial Strategic Innovation Promotion Program (SIP) 3rd Phase, “Development of Smart Mobility Platform” promoted by Council for Science, Technology and Innovation, Cabinet Office. (Project Management Agency : New Energy and Industrial Technology Development Organization (NEDO) (Project Code JPNP23023))