

# Implementation of Level 4 Automated Driving Operations in the Kashiwa-no-ha Area

Partner: Kashiwa ITS Promotion Council, UTmobI, Cool4 Consortium, Fund: RoAD to the L4

## Introduction

Since November 2019, the Kashiwa ITS Promotion Council has served as the implementing body, operating an automated driving bus (Level 2 operation) on weekdays between Kashiwa-no-ha Campus Station and the University of Tokyo Kashiwa Campus. To advance this activity toward the realization of Level 4 automated driving operation (Specified Automated Operation), a six-party consortium was commissioned under the Ministry of Economy, Trade and Industry (METI) and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) “RoAD to the L4” project (Theme 4), commonly known as Cool4. Through this initiative, an automated driving bus and a cooperative automated driving system were developed, and Level 4 automated driving operation was successfully implemented.



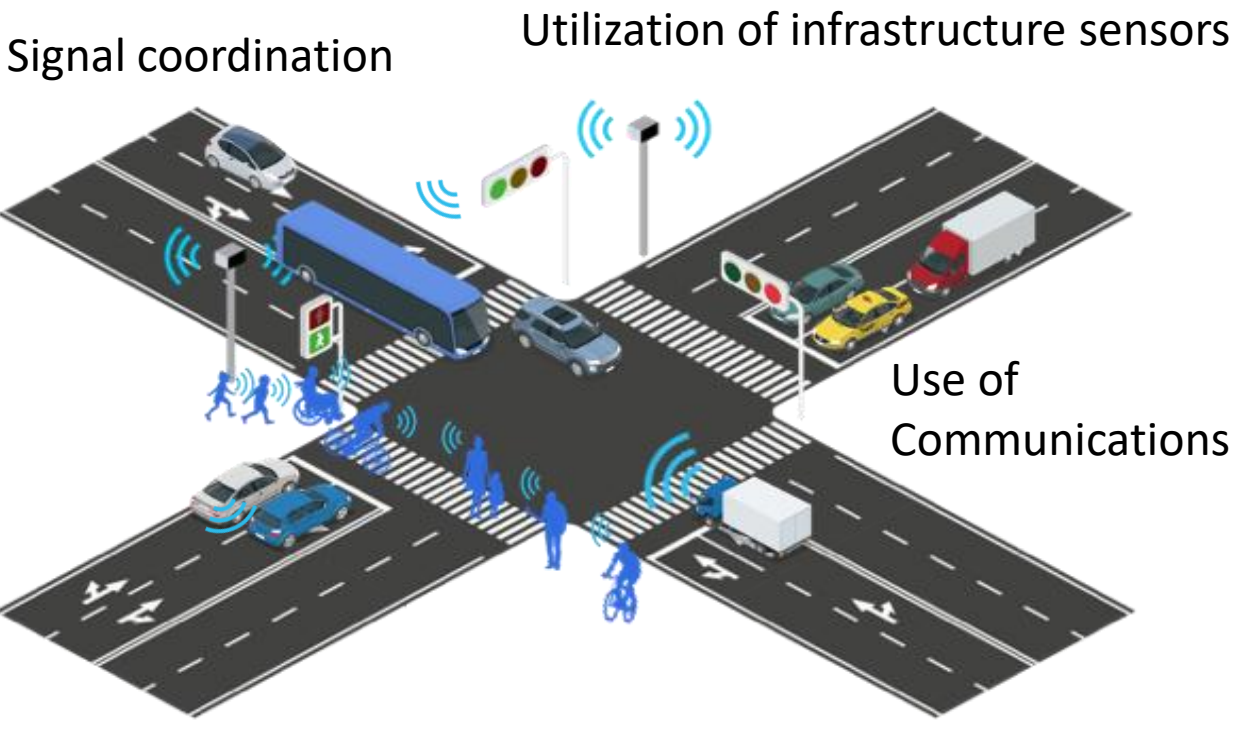
Secretariate The University of Tokyo  
Tokai National Higher Education and Research System (Nagoya University)  
National Institute of Advanced Industrial Science and Technology  
Mitsubishi Research Institute, Inc.  
Japan Automobile Research Institute  
Advanced Smart Mobility Co., Ltd.

## Goal

- Further develop the Level 4 automated driving operation implemented in the Kashiwa-no-ha area.
- Create basic goals and requirements for a cooperative system deployable in the mixed-traffic environments in other regions.

## Cooperated System

This refers to a system that performs automated driving using information other than that provided by on-board sensors, such as information obtained from infrastructure via communications. This system is being developed as a system necessary to realize automatic driving in mixed spaces where pedestrians and other vehicles are present.



## Section for Level 4 automated driving operation

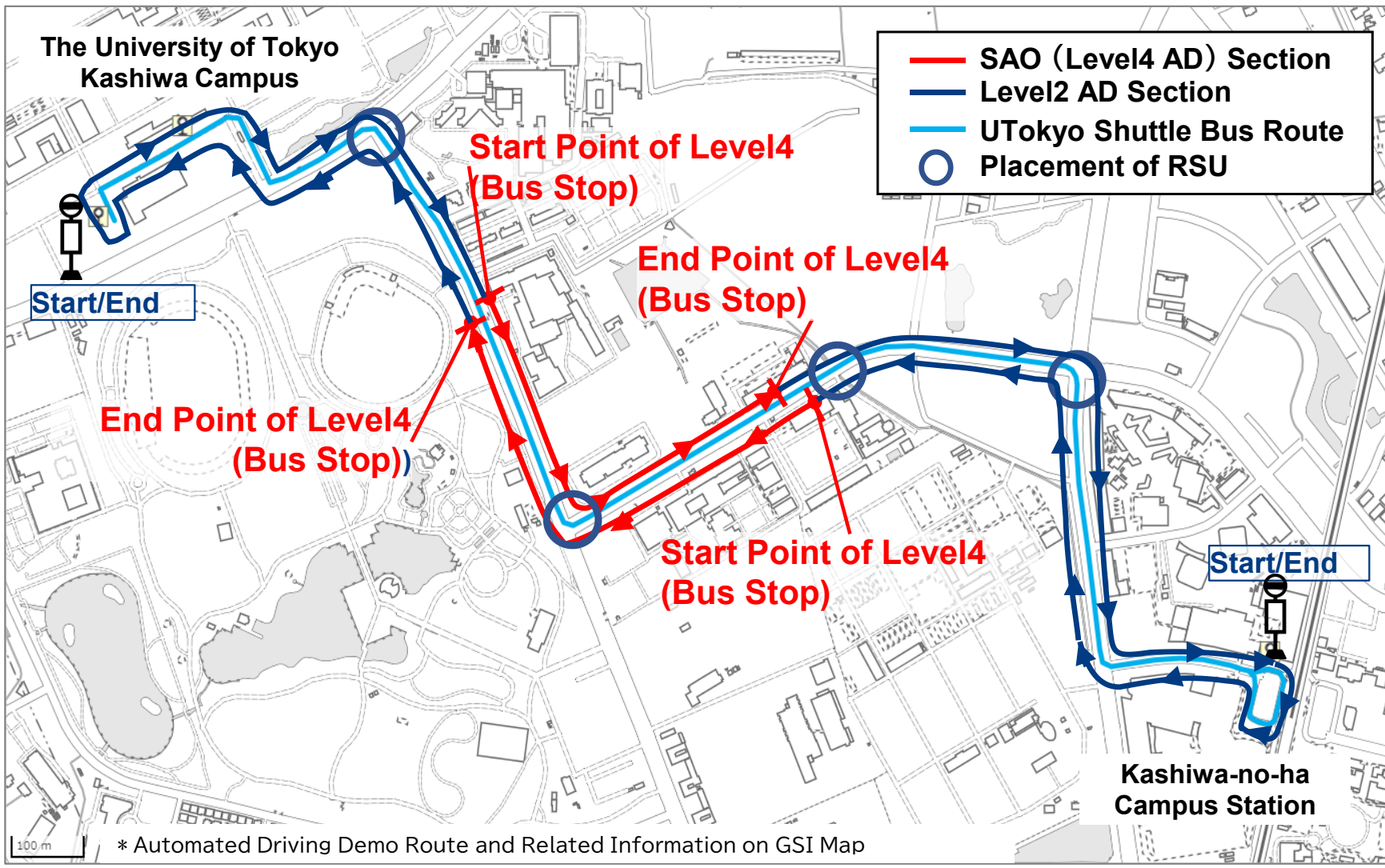
Level 4 operation was achieved on the L-shaped section (red line in the figure on the right).

Switching between Level 2 and Level 4 operation is performed at bus stops.

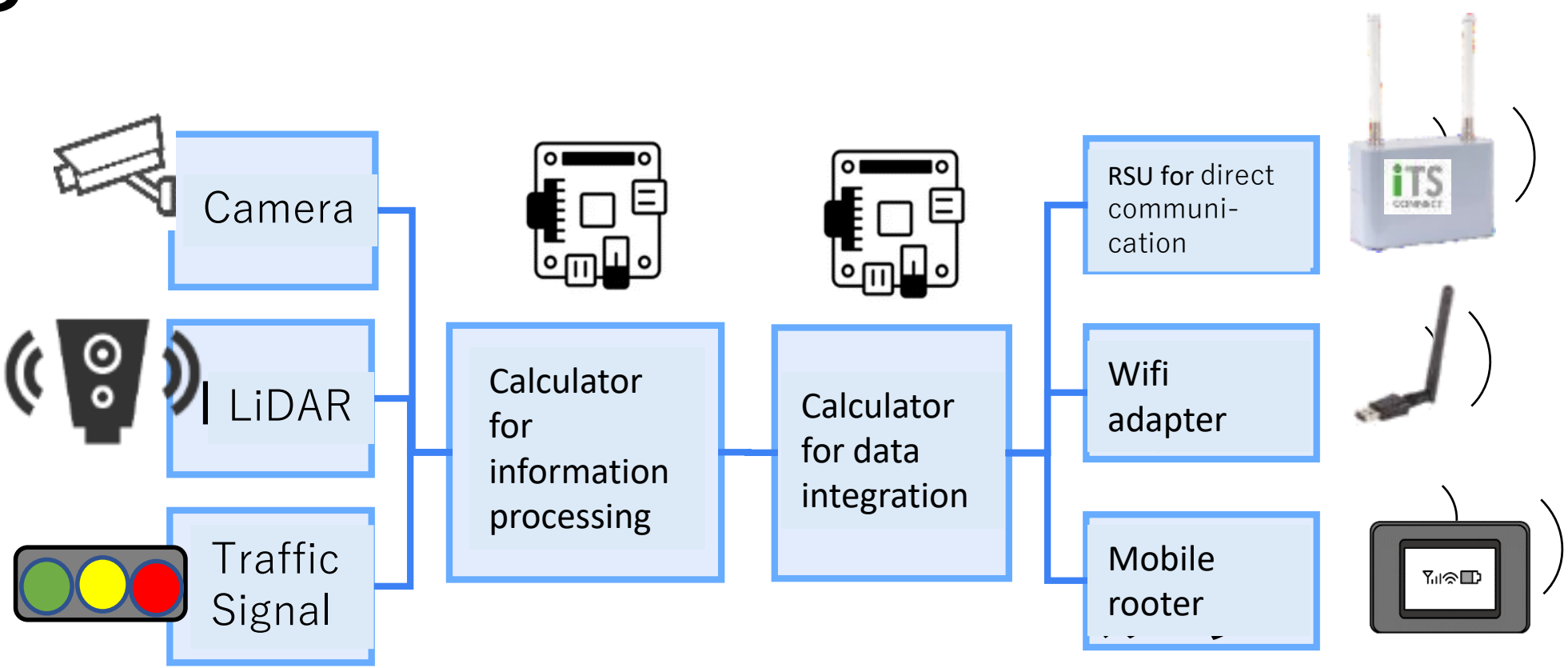
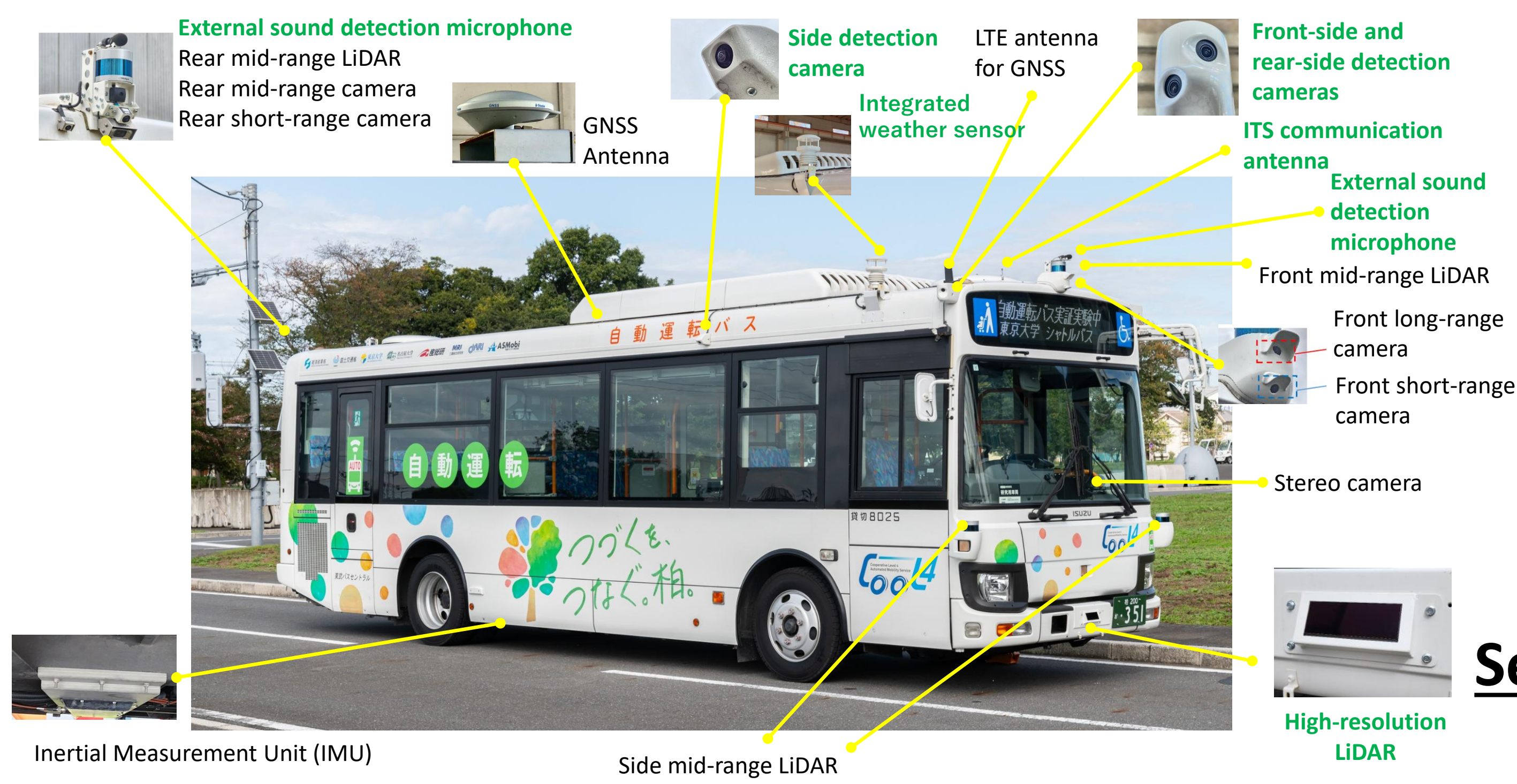
Level 2 operation is maintained on other sections, while continuing technical development to expand the Level 4 operational area.

In addition to onboard camera-based signal recognition, signal information (remaining green time) is utilized.

Other cooperative system functions (e.g., object information) are not used for Level 4 operation; instead, their performance is evaluated to examine future applicability.



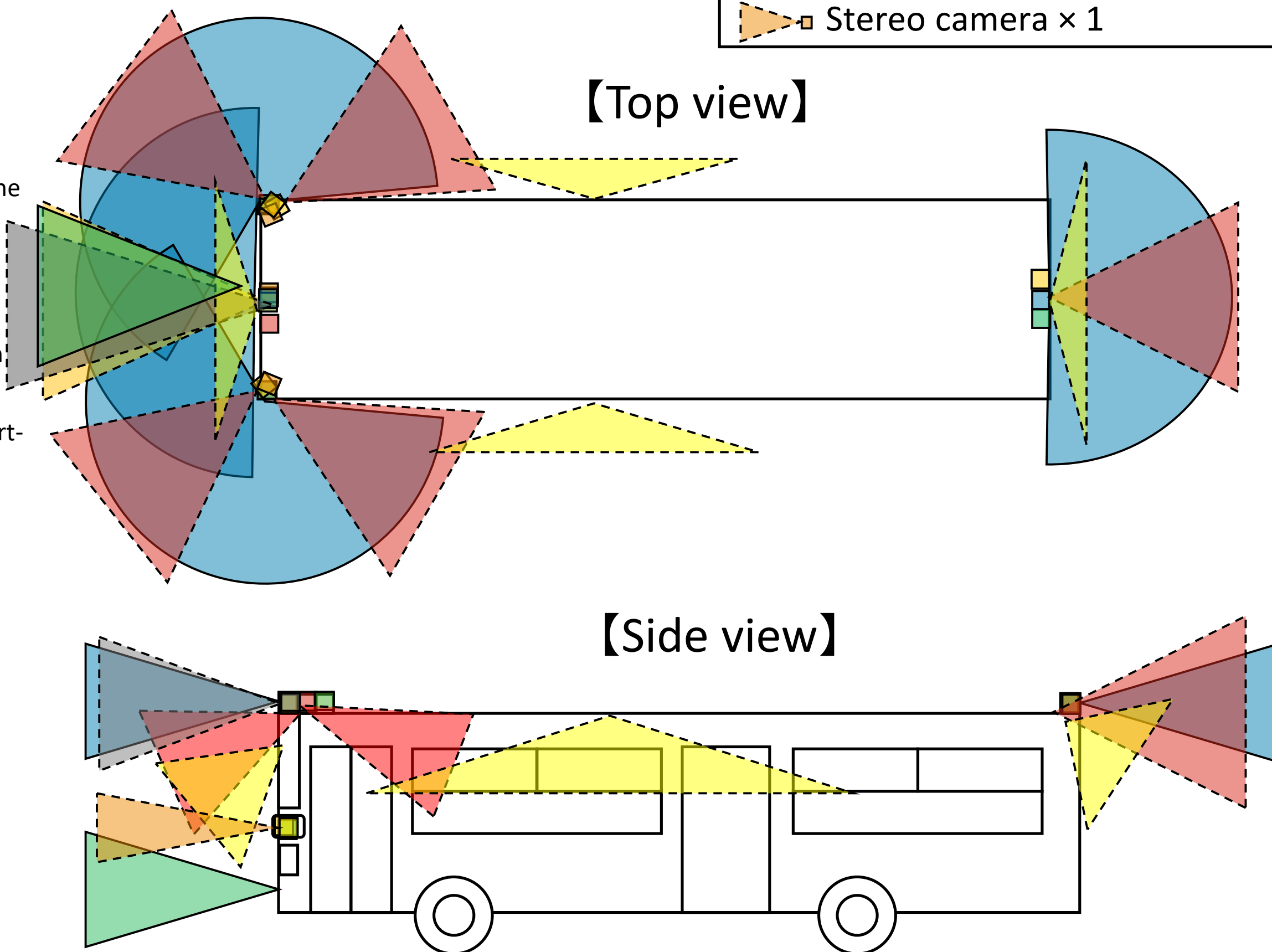
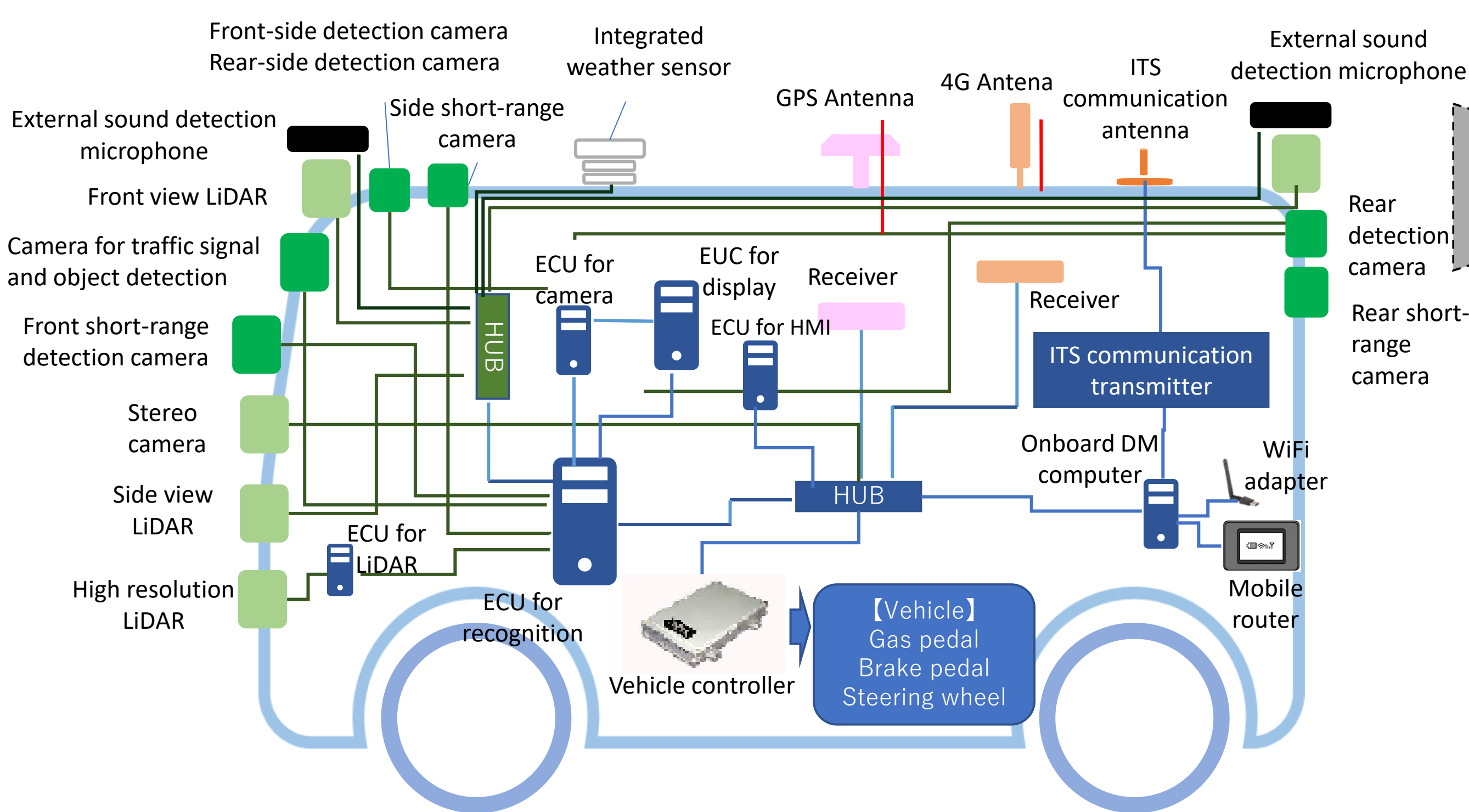
## Overview of the cooperative automated driving



## Sensor Positions

- Mid range LiDAR × 4
- High resolution LiDAR × 1
- Long range & Traffic light recognition camera × 1
- Mid range camera × 5
- Near range camera × 4
- Stereo camera × 1

### Basic configuration of a cooperative automated vehicle



# Infrastructure Information Utilization Policy

Objective: Enhance traffic smoothness using roadside infrastructure data beyond onboard sensors.

Assumption: In addition to avoiding sudden deceleration and acceleration for the safety of passengers on board, buses require more careful driving strategies to avoid flying out of blind spots. This results in a loss of smoothness.

The following benefits are expected from using infrastructure data to adjust braking and acceleration to the situation.

Signal information: Remaining time of signal light ➡ Travelling through intersections avoiding sudden deceleration

Object information: Information on objects in the blind spots ➡ Reduction of passing time when there are no objects in the blind spots

## Example of using object information from infrastructure

- Detects pedestrians and bicycles that may enter crosswalks
- Multiple LiDAR/cameras are deployed to eliminate blind spots.

## Data Integration Platform

- Architecture of the data integration platform developed for cooperative Level 4 automated driving.
- Designed with applicability to vehicles at Level 3 and below.

### Published: Cool4 data integration platform API specifications

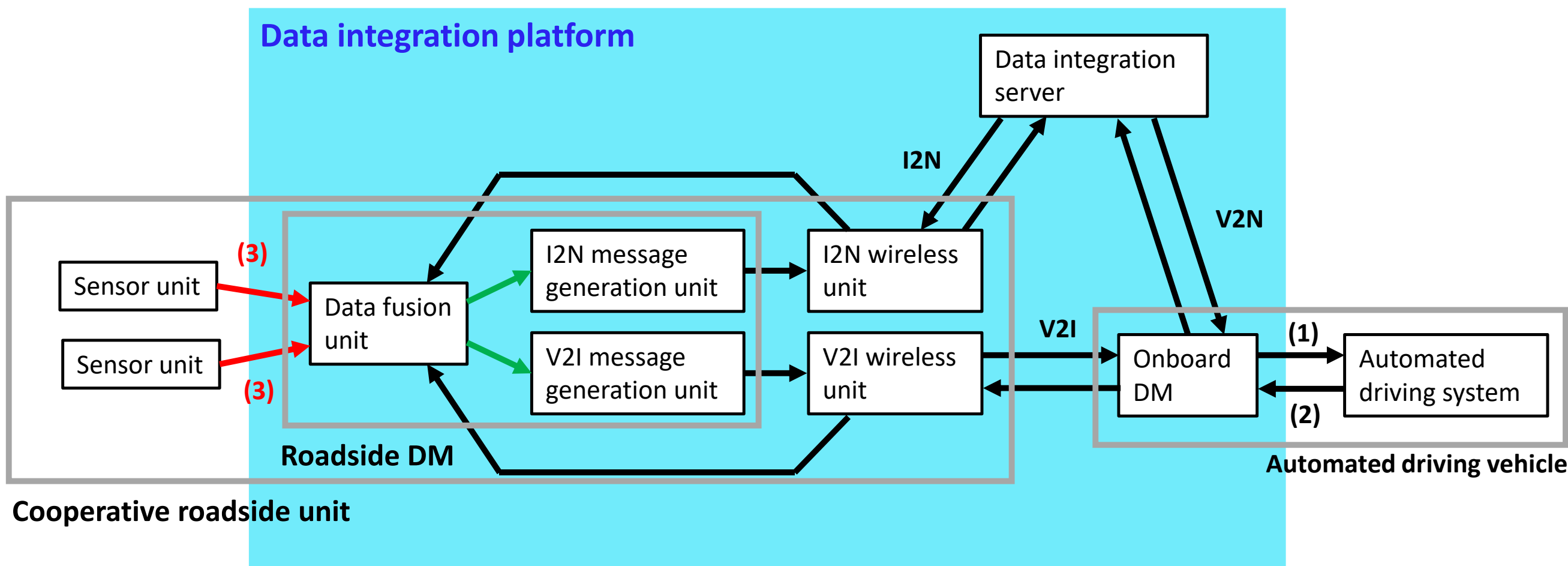
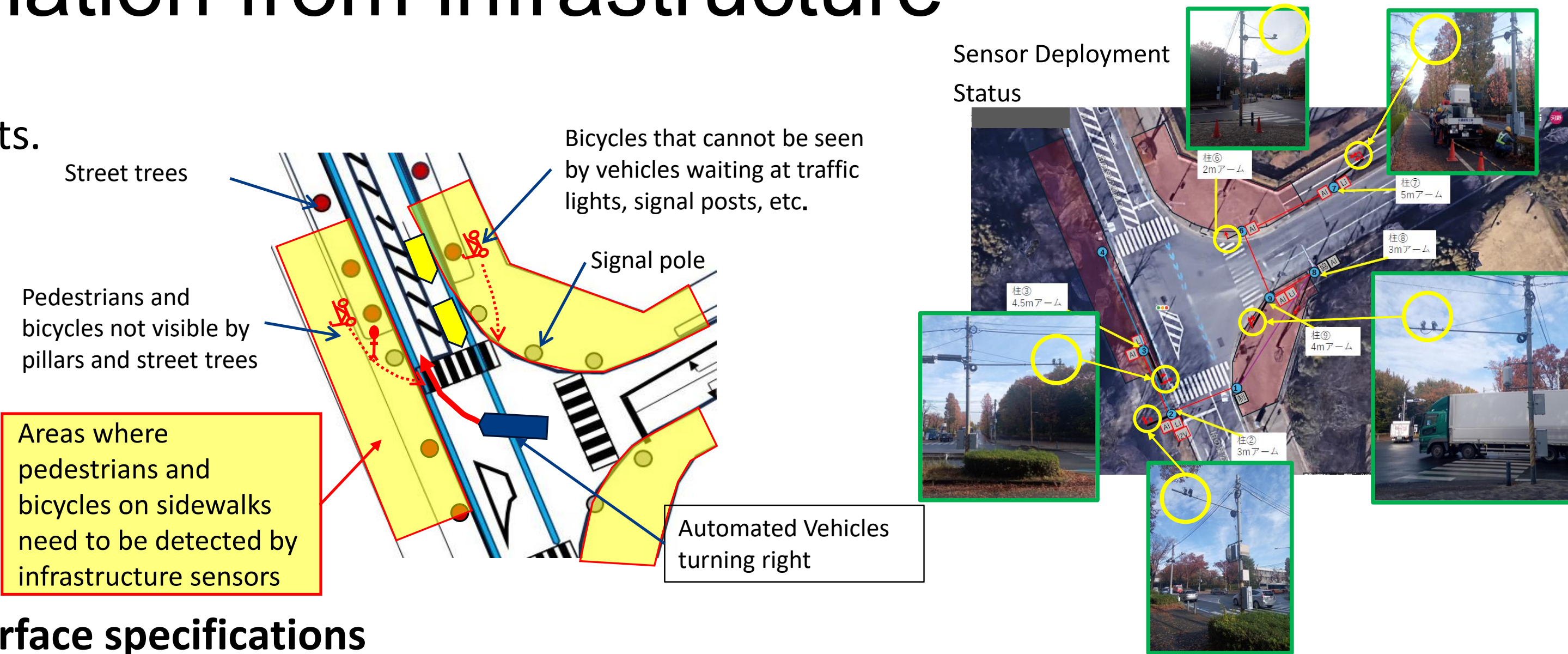
- Interface specifications between the data integration PF and the automated driving system( (1) and (2) in the figure)
- Defines the logical formats of four types of data:
  - Object information,
  - Free-space information,
  - Sensor information,
  - Traffic signal information.
- Defines the methods for acquiring static map information and specifying the required dynamic information

### Published: Sensor interface specifications

- Interface specifications between the data integration platform and infrastructure sensors (item (3) in the figure)
- Harmonized with ITS Japan smart pole specifications
- The specifications were authored by members of the Cool4 team (Nagoya Univ.).

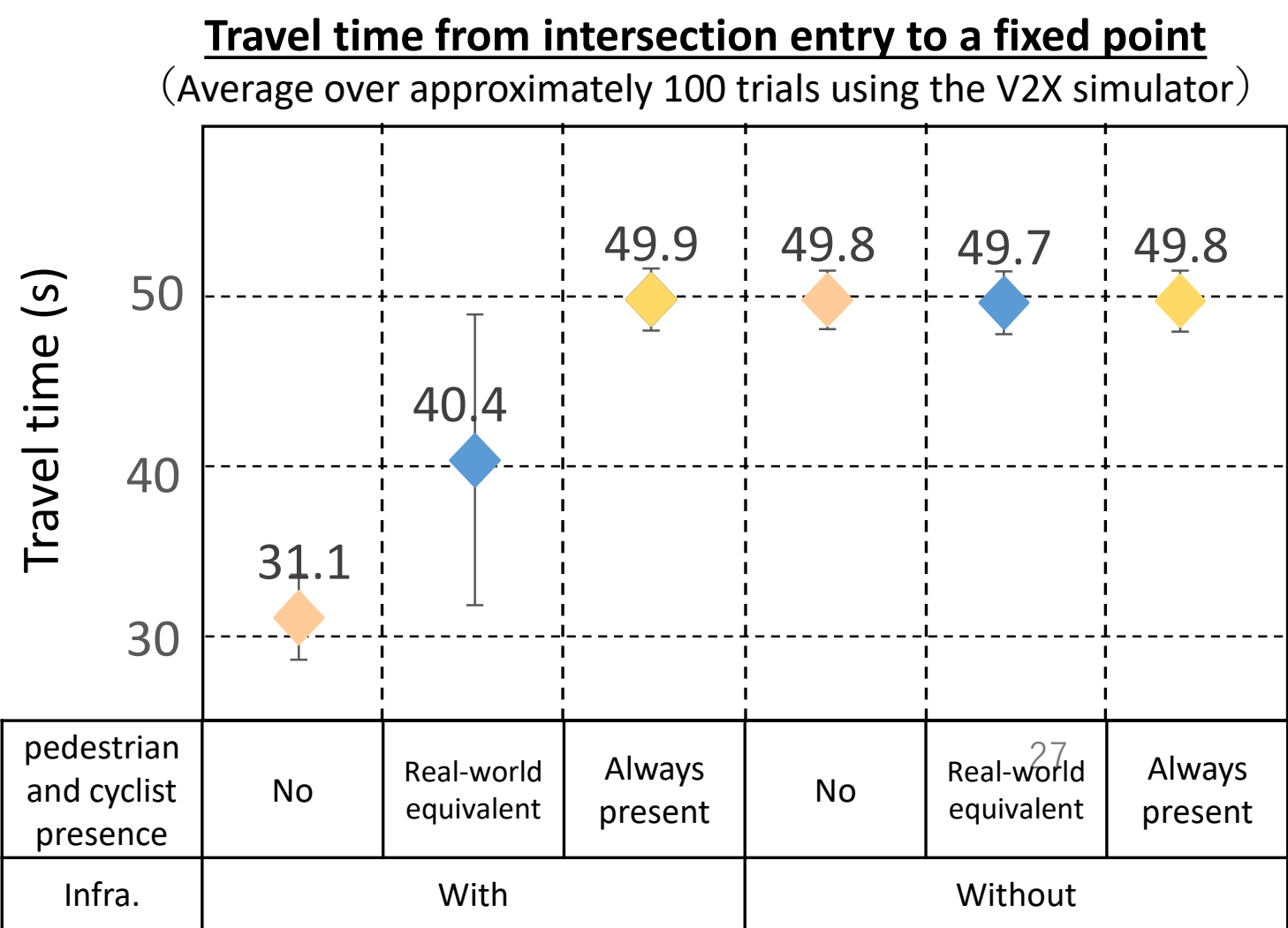
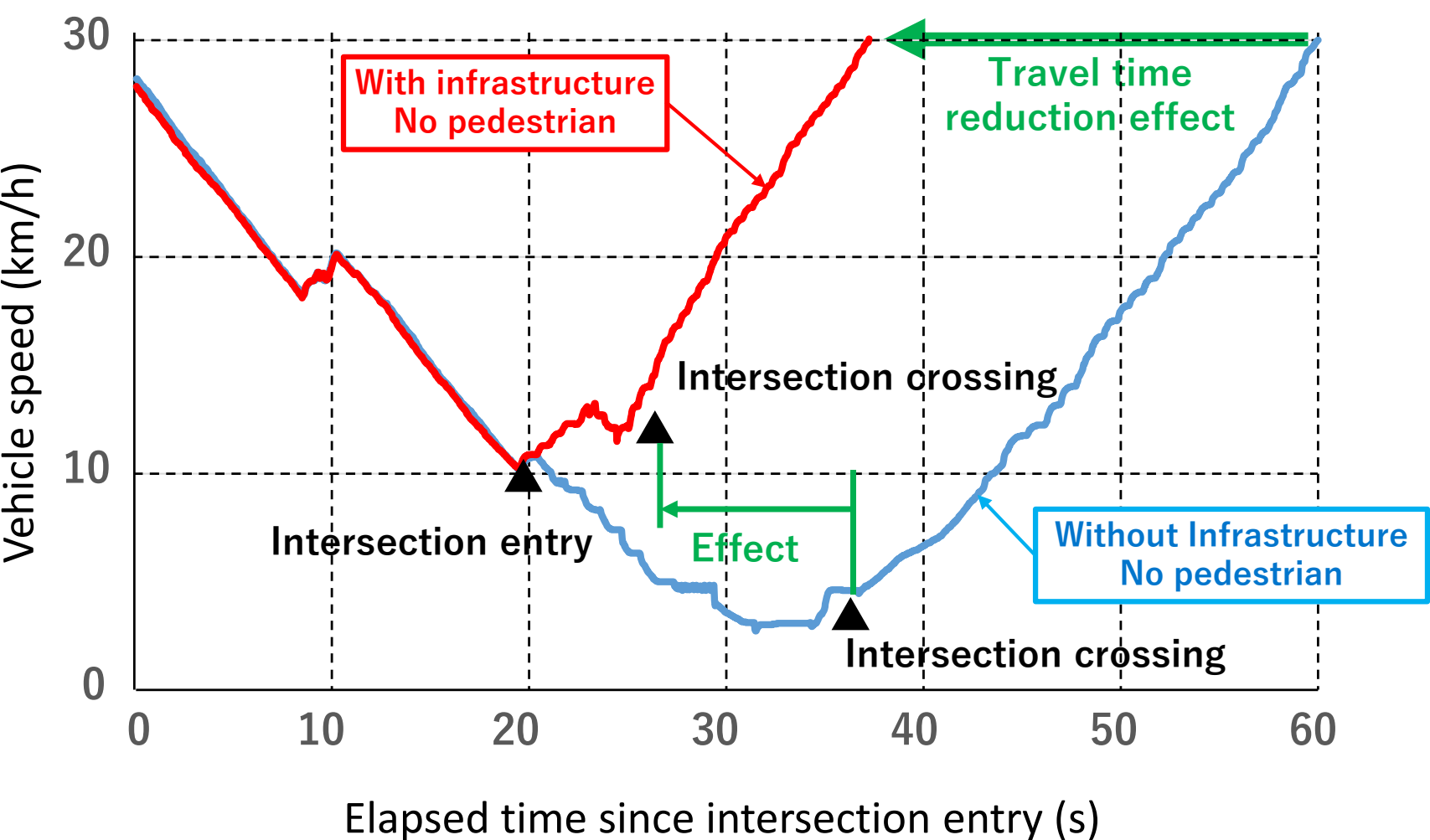
### Open-source release of the data integration PF

The Cool4 data integration platform software, with proven operational deployment in Kashiwa-no-ha, is **planned to be released as open-source software.**



## Cooperative System Evaluation

- Using the developed virtual environment (V2X simulator), the travel time reduction effect of the cooperative system was quantitatively evaluated.
- Pedestrians were generated with probabilities that mimic real traffic, and travel times between fixed points were compared over multiple runs.



## International Cooperation

- Demonstration and discussion of results by inviting foreign experts to Kashiwa-no-ha, Taki Town, Mie Prefecture, Gifu City, Nagoya City, Fukaya City, Shiojiri City, etc.
- Focusing on public mobility services, discussing technical, legal, and social issues for practical application of Level 4 cooperative mobility services
- Survey and disseminate information on overseas trends through international conferences, etc.
- Cooperation with ULTIMO, a project under the European Commission



## Related Documents

<https://www.road-to-the-l4.go.jp/publication/>

