# Lane-Level Road Traffic Information Technologies Utilizing Vehicle Probe Information

**Hirokazu Ichikawa,**
**Pacific Consultants Co., Ltd.**

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SIP

Cabinet Office

SIP-adus Workshop 2020

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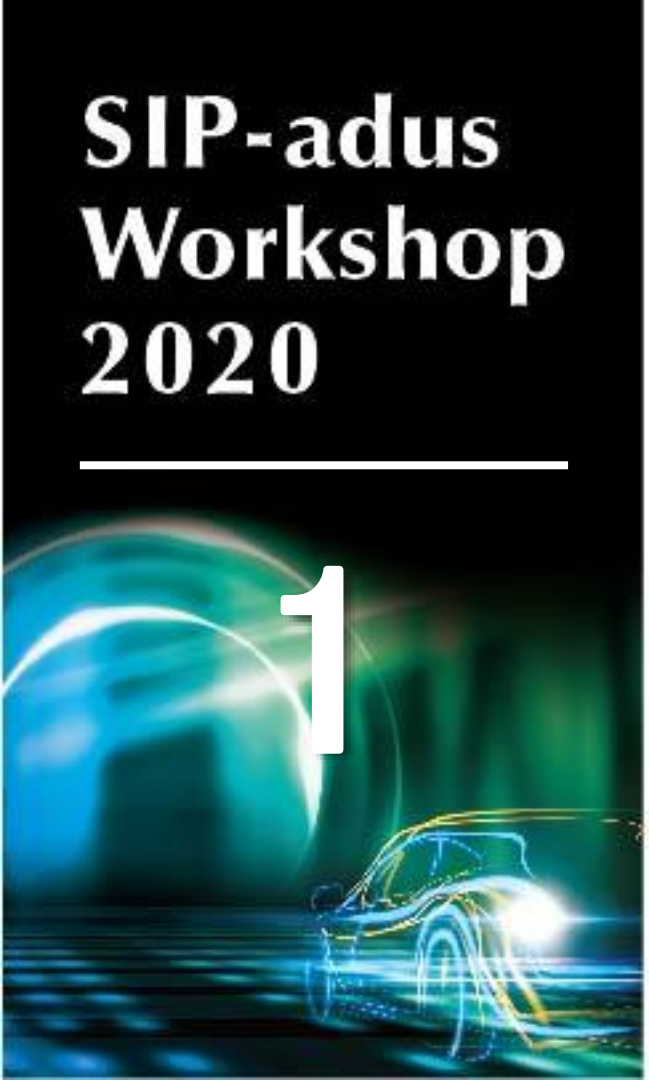



# Implementation Outline

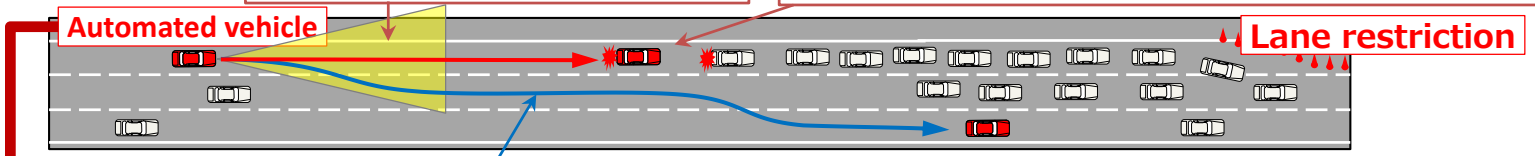
# Necessity of Lane-level Road Traffic Information

- Lane-level road traffic information is necessary to achieve safe and smooth driving by obtaining the status at the front that cannot be detected by in-vehicle sensors, and changing lanes early, or other means.
- To generate lane-level road traffic information, it is effective to use vehicle probe information that can obtain traffic conditions in areas, and further sophistication of information by adding information from road/traffic controllers or others is expected.

W/o info.

Autonomous driving based on restricted information from the front detectable with in-vehicle sensors

Sudden deceleration by the preceding car will cause a risk for the automated vehicle located at the congestion tail to decelerate accordingly, and unable to change lanes smoothly.




W/ info.

Obtaining lane-level information at the front preliminarily gives enough time for early lane change, etc.

**Needs by vehicle**

- What lane should be used?
- When to change lanes?

→ **Lane-level road traffic information is necessary** to determine the above.

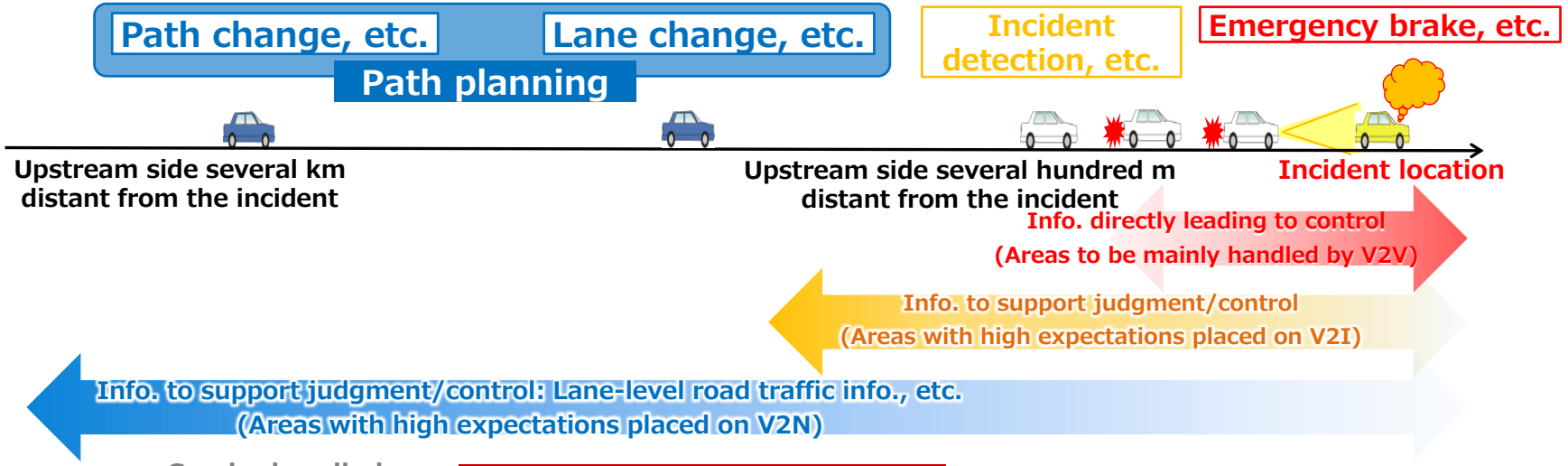
Respond to needs

**Effectively generating information by combining information from various sources**

- ○ **Vehicle probe information**
  Can obtain areas and positions precisely
- ○ **Road/traffic controller information**
  Can obtain information such as incident causes that cannot be obtained through vehicles
- ○ **Others (emergency information, etc.)**
  Can obtain emergency information immediately

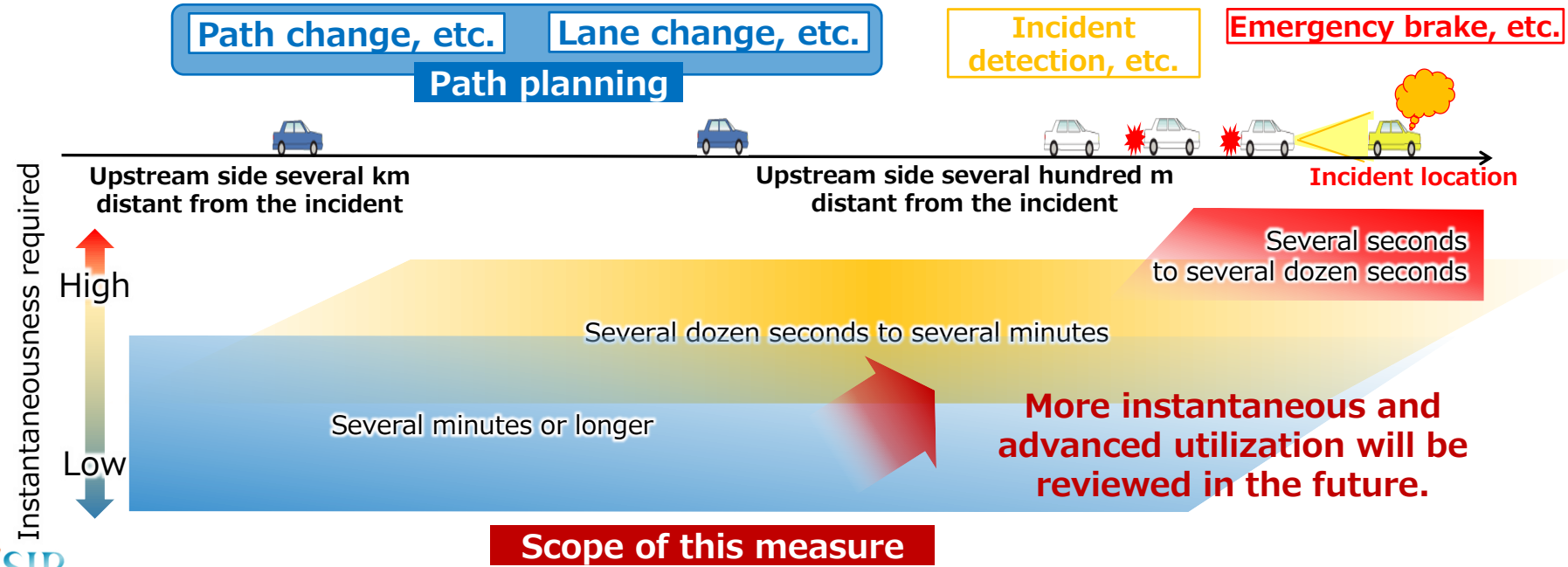
# Scope of This Measure

- There are multiple stages for automated vehicles to appropriately control or make judgment, depending on the distances to the point to perform controls necessary for individual scenes. Thus lane-level information is required for each stage.
- It is important to use various communication measures depending on the characteristics of each stage, and integrally combining obtained information.
- Lane-level road traffic information according to characteristics of scenes is being reviewed for the effectiveness or use, and this measure first reviews use of path planning mainly for lane change.



# Scope of This Measure

- This measure utilizes vehicle probe information already implemented to realize an early social implementation and starts activities from reviewing technologies to generate/provide information in real time similar to conventional road traffic information.
- It also aims to generatee/provide further instantaneous information in the future.

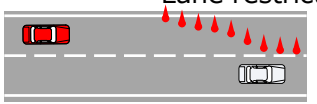


# Target Use Cases and Advantage of Information Provision

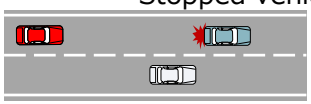
## Target use cases

Targets **three use cases** being studied by Japan Automobile Manufacturers Association

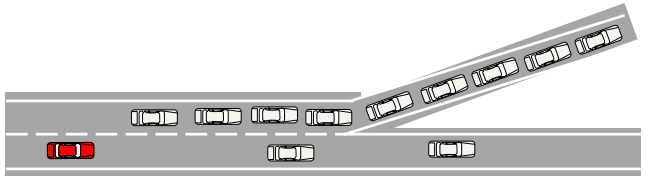
**A: Lane restrictions (due to construction work or the like)**




**B: Traffic accidents, disabled vehicles, fallen objects, and other obstacles**




**C: Congestion tail**



| Requirement | Target sections | Communication | Control application (vehicle control or information provision, etc.) | Quick response (response from vehicle after obtaining information) |
|---|---|---|---|---|
| | Expressways | V2I, V2N | Lane change, traveling plan change, speed adjustment, stop | Not required |

Note) Set based on the SIP Cooperative Automated Traveling Use Cases (1st Edition, September 3rd)

## Advantages of info provision

- **Improvement on safety and smoothness, etc. is expected** thanks to smooth lane change and prevention of impact collision by the following car, as well as sudden deceleration of the automated vehicle when meeting an event shown in use cases by changing the lane in an early stage based on the situation of the front area.
- **Effective as support information for vehicles with automated driving levels 1 and 2.**

# Future Visions and Scope of Study of FY2020

- In the future, data amount will be increased in line with widespread use of connected cars, so we will proceed with the study assuming that latest information will be provided thanks to collection of data without uplink delay.

Information to be used

| ① Current situation (Field operational tests) (FY2020) | ② Future vision as extension of current technology (Transition period) | ③ Future ideal vision |
|---|---|---|
| **Probe info (commercial)**<br>• Less data<br>• Delay in uplink<br>• Road link data (per 100 m section, speed distribution)<br>• 5-minute summary, 5-minute update | **Probe information**<br>• Large amount of data<br>• Decrease in uplink delay<br>• Road link data (leveraging turn signal information, etc.)<br>• 1-minute summary data<br>**Infrastructure information**<br>• Traffic control information (lane restrictions, accidents, etc.) | **Probe information**<br>• Large amount of data<br>• Further decrease in uplink delay<br>• Leveraging lane-level data (speed, turn signal information, etc.)<br>• 1-minute or shorter time data<br>**Infrastructure information**<br>• Traffic control information (lane restrictions, accidents, etc.)<br>**Other look-ahead information**<br>• Emergency information (accidents, etc.) |

**Contents for FY2020**

**Perform field operational tests targeting 2 routes of Metropolitan Expressway to verify the following matters.**

- Verification of the possibility of generating lane-level road traffic information
- Review of necessary technical specifications
- Verification of the effectiveness of information

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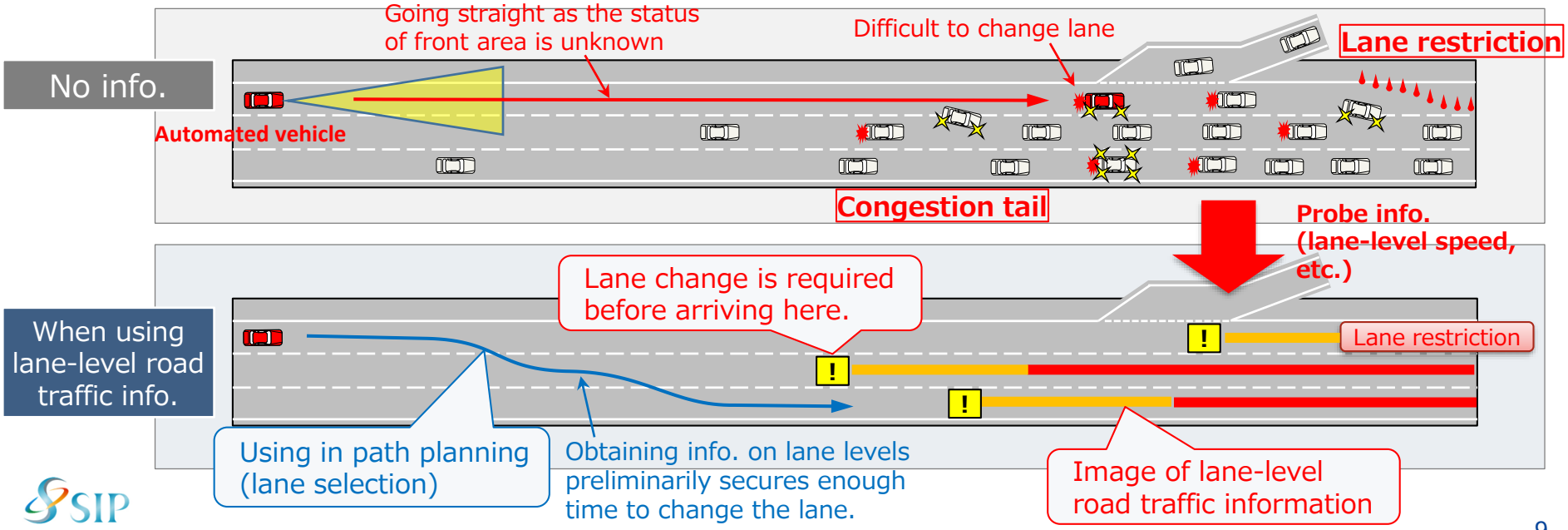
# Probe Information to be Used and Lane-Level Road Traffic Information Generated

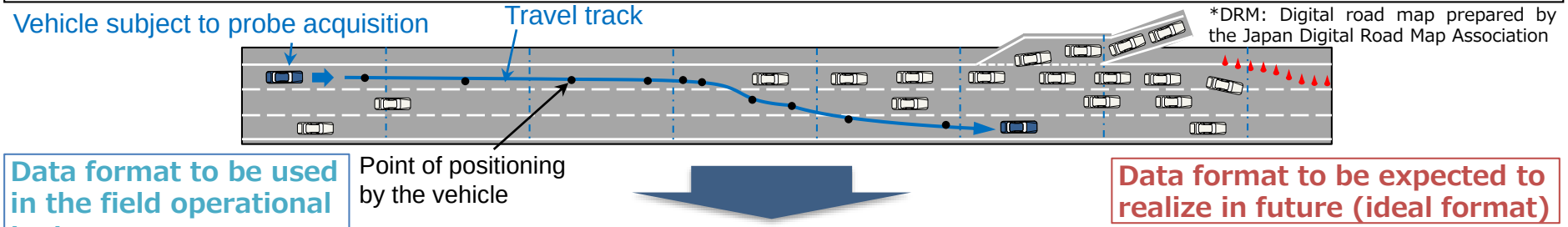
# Image of Lane-Level Road Traffic Information

- This measure assumes the following lane-level information will be generated.
  ○ Information on start point of abnormal traffic flow, ○ Information on abnormal traffic areas ○ Information on event cause
  →**Warning information assuming the use in <u>path planning (lane change)</u>**



# Available Probe Information

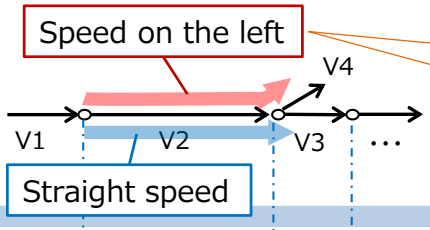
- **The spatial aggregation unit of probe information (such as speed) is generally a link aggregation such as DRM*.** (Pattern 1)
- **It is desirable to use lane-level probe information (Pattern 3) to generate lane-level road traffic information, but in real terms commercial-base data (data obtained by commercial vehicles) are road-specific linked information** (Patterns 1 and 2)
- Therefore, using probe information of Patterns 1 and 2 to generate lane-level road traffic information is being studied.



# Characteristics of Probes to be Used

## <Information held by links for probe information to be used>

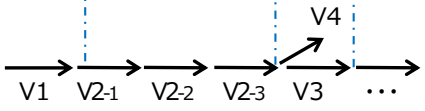
**<Pattern 1>**
**DRM links (road link)**
- Speed by direction at links before junction



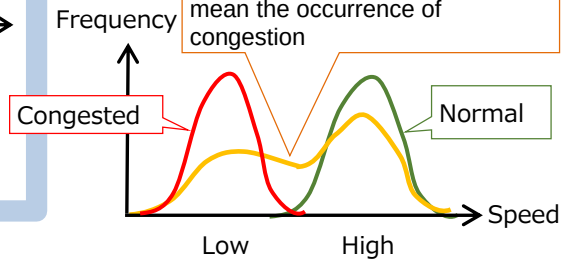

**Speed by direction at links before junction**

If the speed on the left is low, it is estimated that there is a congestion in the left lane.

**<Pattern 2>**
**DRM links (100 m equal interval)**
- No. of vehicles by speed range
- Frequency on vehicle events (such as turn signals)




**Frequency by speed range (speed distribution) )**




**Frequency on vehicle events**

| Turn signal | Freq. |
|---|---|
| Left turn signal | 15 |
| Right turn signal | 0 |
| Left steering | 15 |
| Braking | 9 |
| : | |

If many vehicles indicate left turn, it is estimated that there is a trouble ahead in the left lane.

If many vehicles use braking, it is estimated that there is a trouble ahead.

- Identifies a position where an abnormality occurs in the traveling direction at 100 m intervals from information on No. of vehicles by speed range in Pattern 2.
- For lane-level abnormality, the direction (left or right) of the lane having the trouble is judged from turn signal information or the like in Pattern 2.
- At junctions, lane-level congestion status (left turn or straight) by branch direction is judged from the speed information by direction in Pattern 1

# Details of Probe Information to be Used

- **Uses of probe information obtained from probe operators** are roughly divided into desk study to evaluate the reliability of information generated with the established method, and verification of experiment system by actually distributing information to experiment participating vehicles during the 2020 field operational test.
- **Probe information will be totaled in every** 5 minutes, considering current data collecting status or other factors.

## Probe information to be used in field operational test

| Unit of links for data collection | Data item | | Field operational test | |
|---|---|---|---|---|
| | | | Desk study (using past data) | Verification with experiment system (online/real-time data) |
| **Pattern 1** In DRM links | Speed by branch direction (5-minute interval) | Speed by branch direction at links before junction | ○ | ○ |
| **Pattern 2** In DRM links (100 m interval) | **Link speed** (5-minute interval) | Average speed | ○ | ○ |
| | | No. of vehicles by speed range(1) | ○ | ○ |
| | **Frequency on vehicle events** (5-minute interval) | Brake | ○ | Expected to be used in the following fiscal year and thereafter |
| | | Turn signal | | |
| | | Steering | | |

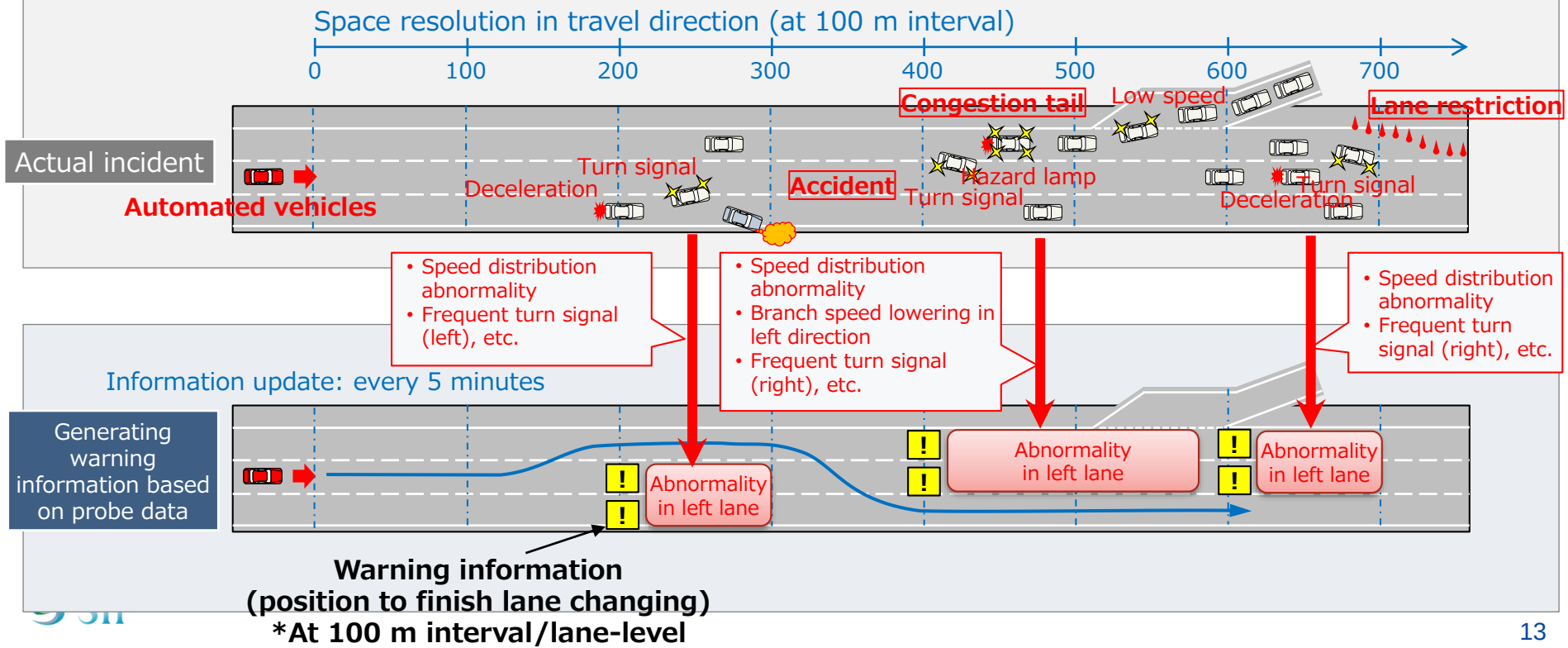
**Scope of data to be used in verification with experiment system**

**Note 1) Image of data format on No. of vehicles by speed range**

| Speed category | No. of vehicles |
|---|---|
| 0<V≦10km/h | |
| 10<V≦20km/h | |
| : | |
| 110<V≦120km/h | |
| 120<V | |

# Lane-Level Road Traffic Information to be Generated

- Generation of the following warning information applicable to target use cases is studied
- Since vehicle event information processing functions are not implemented in the experiment system for verification, use cases for congestion tails at the junction will be mainly verified.



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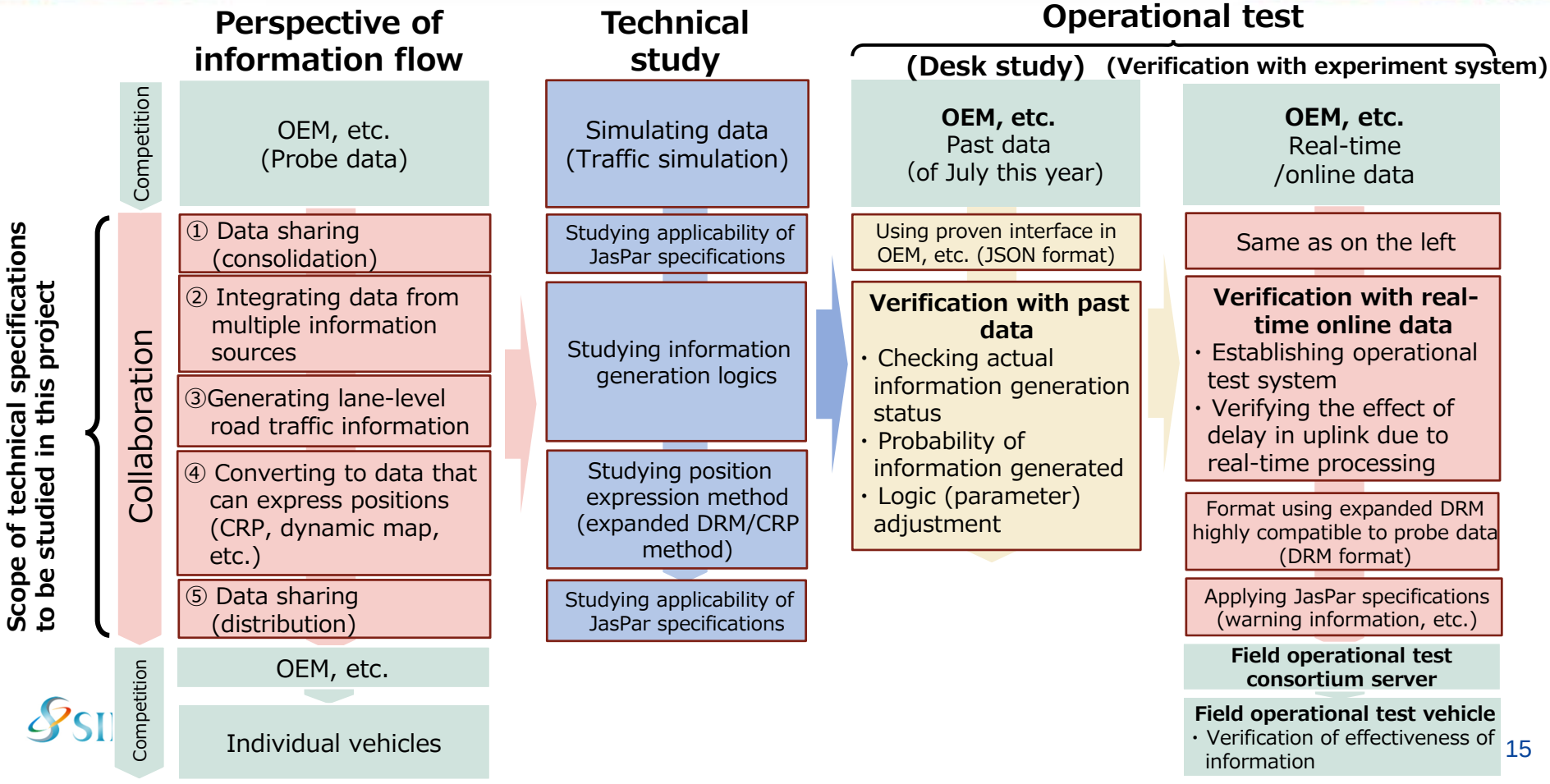
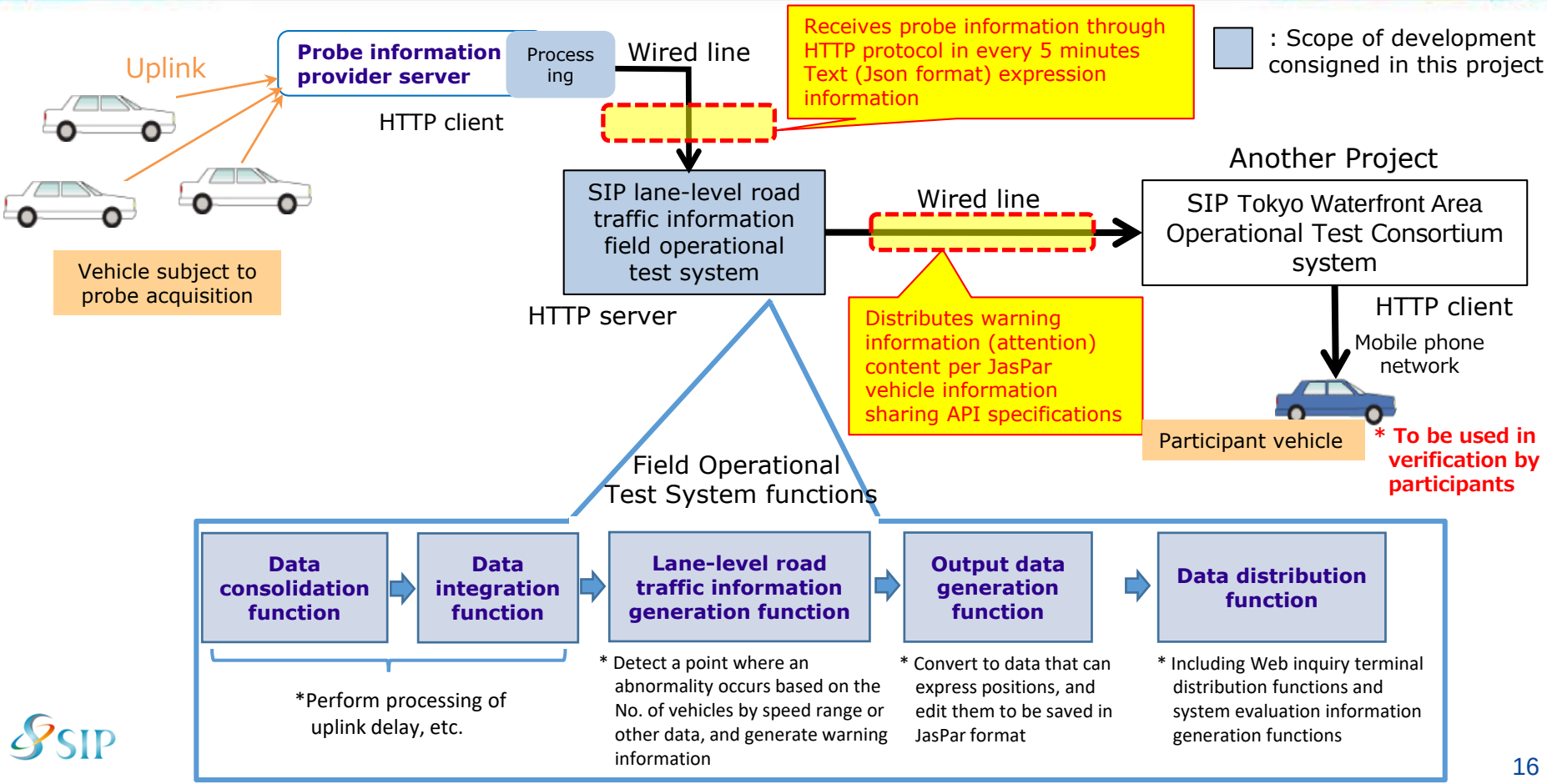
# Technical Study Details and Field Operational Test Policy

# Details of Operational Test Corresponding to Technical Study

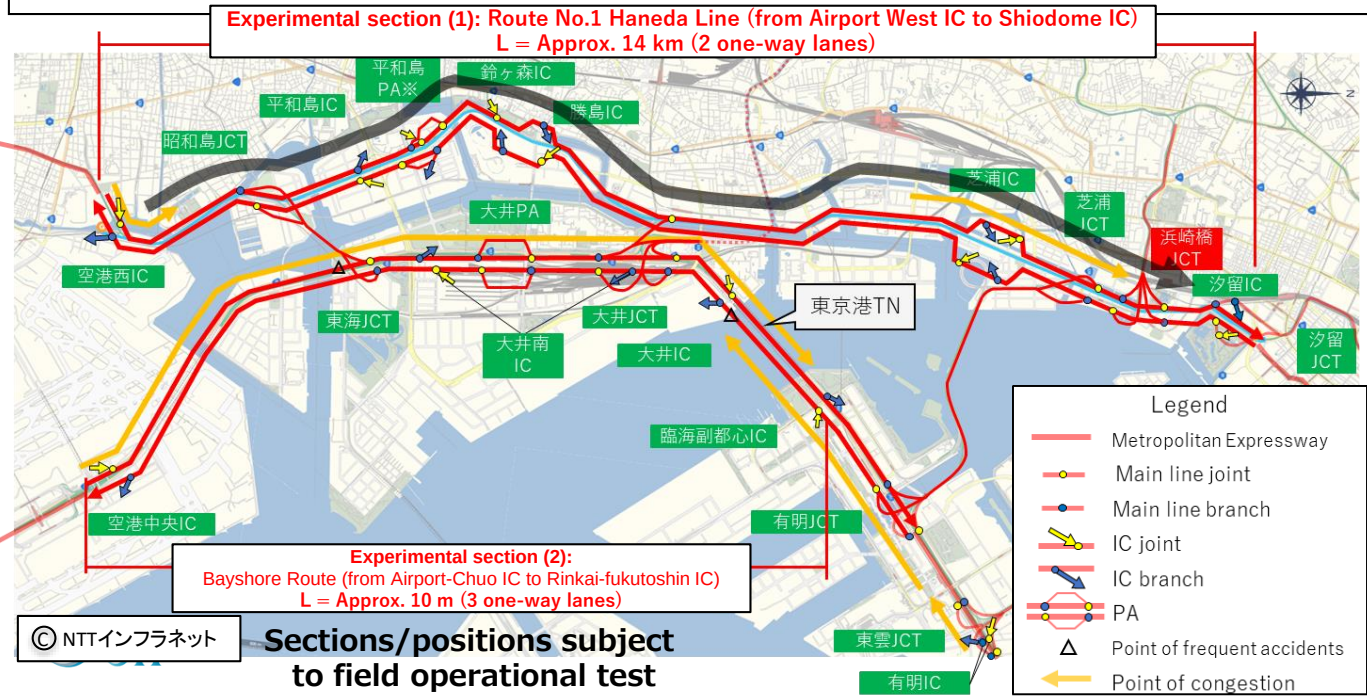


# Configuration of Field Operational Test System



# Information Distribution Sections for Field Operational Test System and Verification by Participants

- Distribute information in the experiment target sections as shown in the following diagram to check data processing/information generation technology or the like.
- For the inbound Route No.1 Haneda Line (section starting at the Hamasakibashi JCT) having frequent lane-level congestions at the junction, experiment participants will travel the section, receive/view information, and evaluate the effectiveness of information, etc.

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**Sections/positions subject to field operational test**

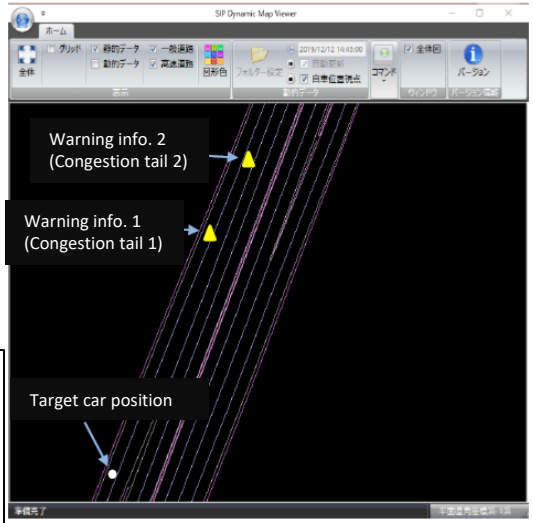
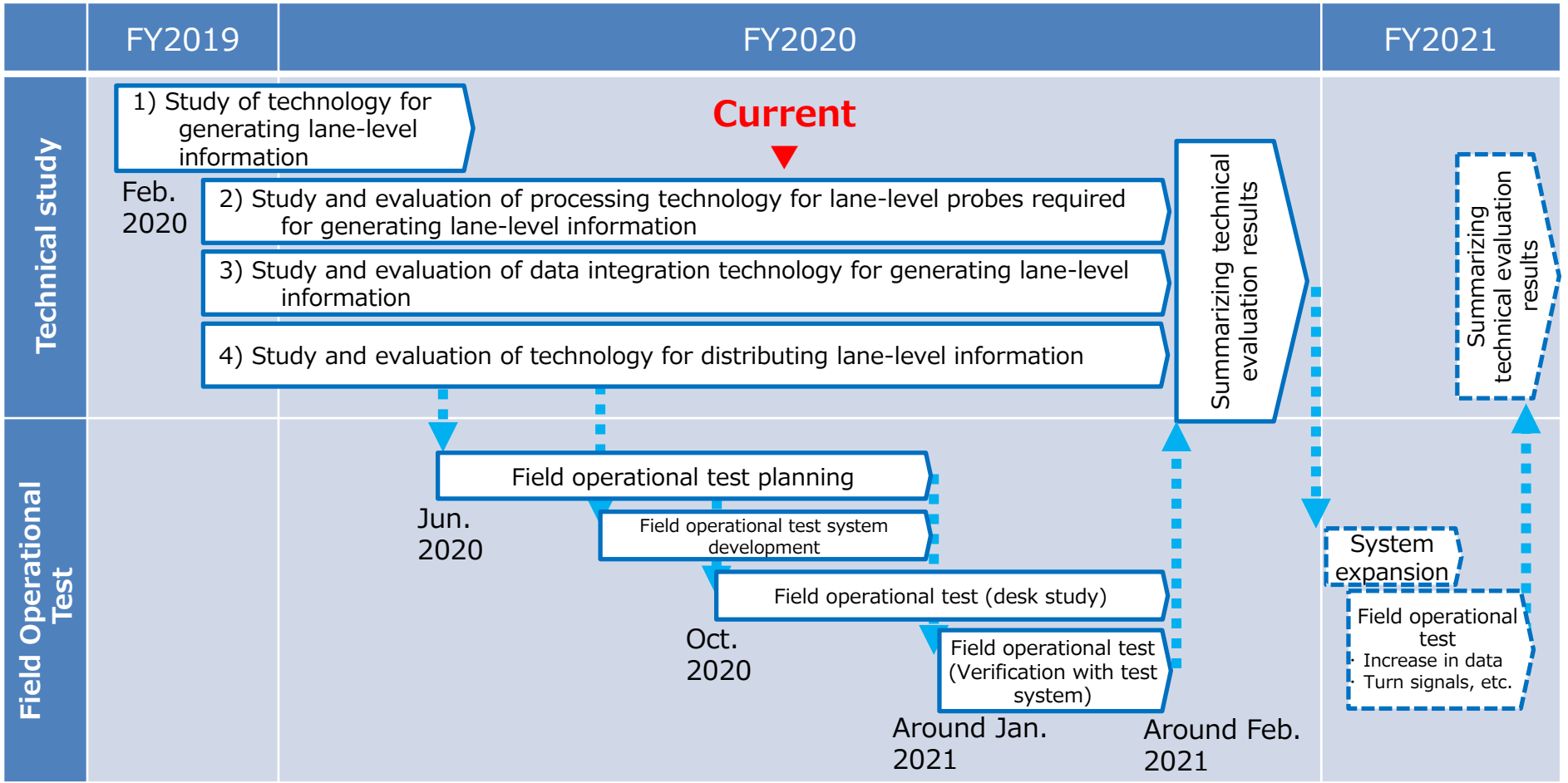



**Image of viewer for lane-level road traffic information (warning information) to be distributed (under review)**

# Implementation Schedule



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Thank you