Cross-ministerial Strategic Innovation Promotion Program

「Cross-ministerial Strategic Innovation Promotion Program (SIP)/ Automated Driving for Universal Services/ Optimized Processing for Dynamic RoadInformation by V2X with Multi-Scale Architecture」

FY 2019 Report

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Oki Electric Industry Co., Ltd.
Sumitomo Electric Industries, Ltd.
Panasonic Corporation

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Background

Assumed problem

Automated driving vehicle **could affect traffic flow**

- In a complicated environment such as intersections, the blind spot of the vehicle's sensor will widen
- As a result, the vehicle will stop or drive slowly before intersections until safety inside intersections can be confirmed

The goal of the R&D

To solve the problem mentioned above, help automated driving vehicle to

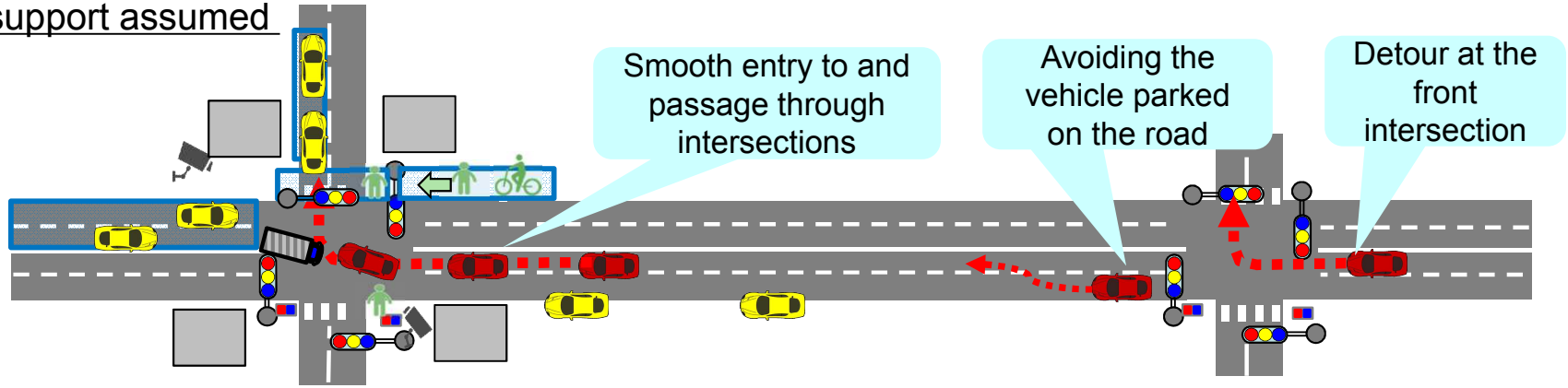
① **Smoothly enter and pass through intersections**

② **Change lanes or routes in advance before intersections**

by collecting and integrating the target information in blind spots* from multiple information sources (existing sensor, advanced sensor, etc.) and distribute to the vehicle.

- In the range that cannot be recognized by the sensor of automated driving vehicles

The support assumed



Assuming control by vehicle's own sensor, support by communication technologies is assumed

The aim of this program

In order to implement the above support, formulate

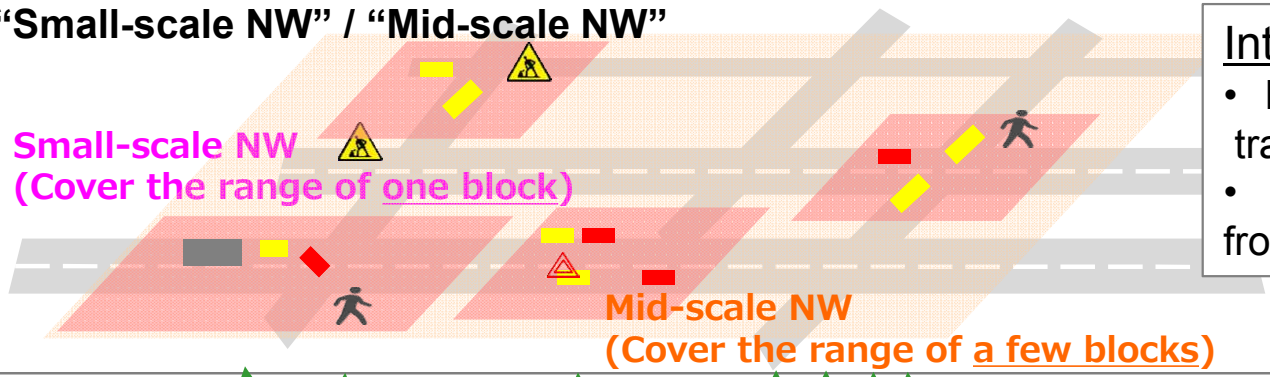
- **communication method / common interface for collecting information** from multiple information sources
- **an draft index for integrating collected information**
- **an method for distributing collected information** to the automated driving vehicle

Overview

Collect and **integrate** dynamic information **from multiple sources as real-time traffic conditions**, and **distribute** only the required range of information **in a format that can be shared with the information on the automated vehicle side**（linking with dynamic maps is considered）

→Assists the automated vehicle to recognize the states of the object (position, attributes, etc) in non-line-of-sight(NLOS) and the out-of-range road situation

“Small-scale NW” / “Mid-scale NW”



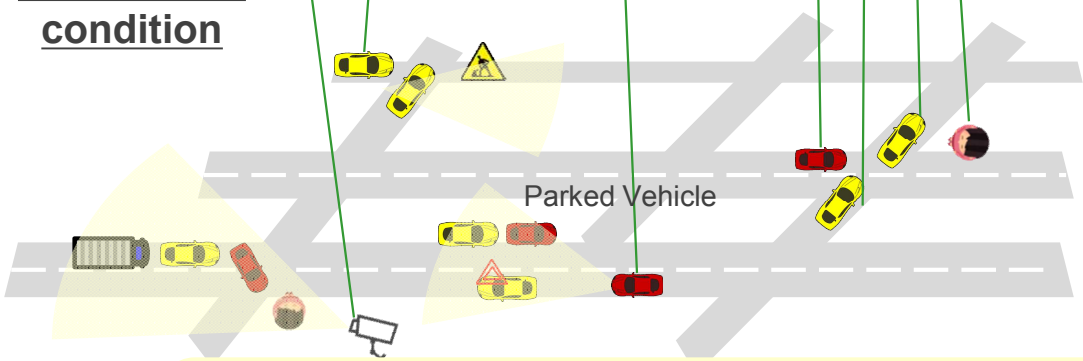
Integration

- Integrate collected information as real-time traffic conditions（Small-scale NW）
- Widely Integrate the information obtained from multiple Small-scale NW（Mid-scale NW）

Real Traffic condition

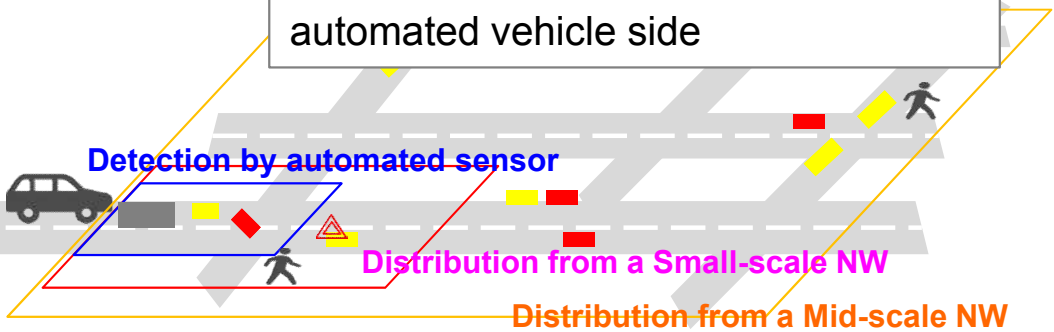
Collection

Collecting dynamic information from multiple sources on the NW side

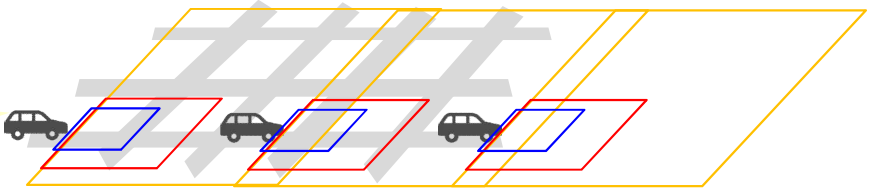


Distribution

Distribute only the required range of information in a format that can be shared with the information on the automated vehicle side



The distribution range from the distribution source (in “Small-scale NW” / “Mid-scale NW”) switches according to the location of the destination vehicle



Use Case In Small-scale NW

To support the smooth entry to and passage through intersections with complicated traffic environments, **grasp traffic conditions inside and near intersections and distribute them to the vehicles**

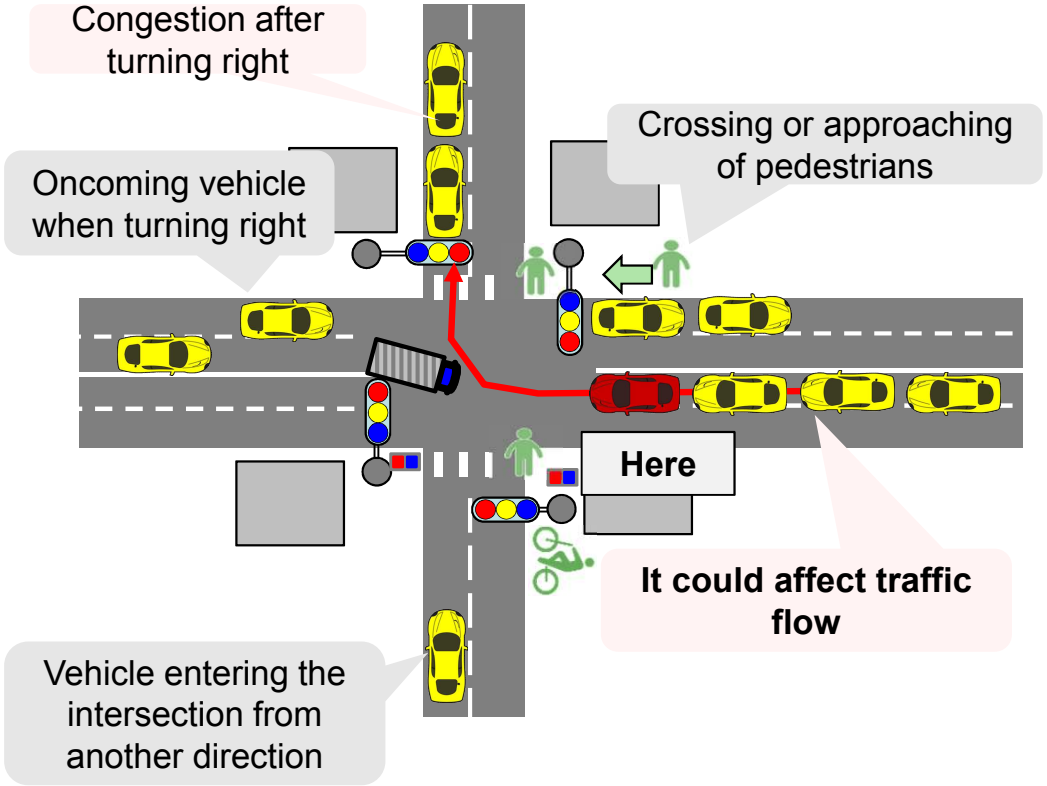
Before

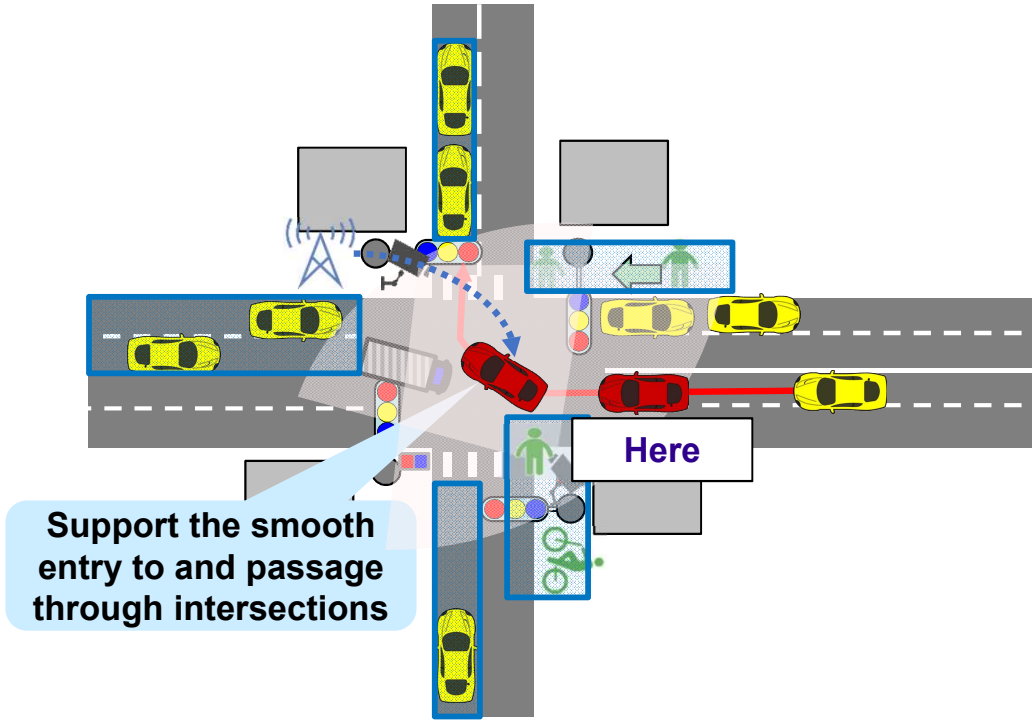
Due to obstacles such as surrounding buildings and vehicles, the sensor of automated driving vehicles **cannot recognize information in blind spots**
→Automated driving vehicle **could affect traffic flow** by stopping before intersections when entering it or staying inside intersections when passing through it

After

Collect **the information out of sight of an automated driving vehicles** from
- other vehicles running around the intersection
- existing roadside infrastructure installed near the intersection

etc. and **distribute it to vehicles before entering it**
→Support the smooth entry to and passage through intersections when there is congestion after turning right, the crossing or approaching of pedestrians / bicycles etc.
→Achieve smooth traffic flow





* Objects painted in gray are already recognized

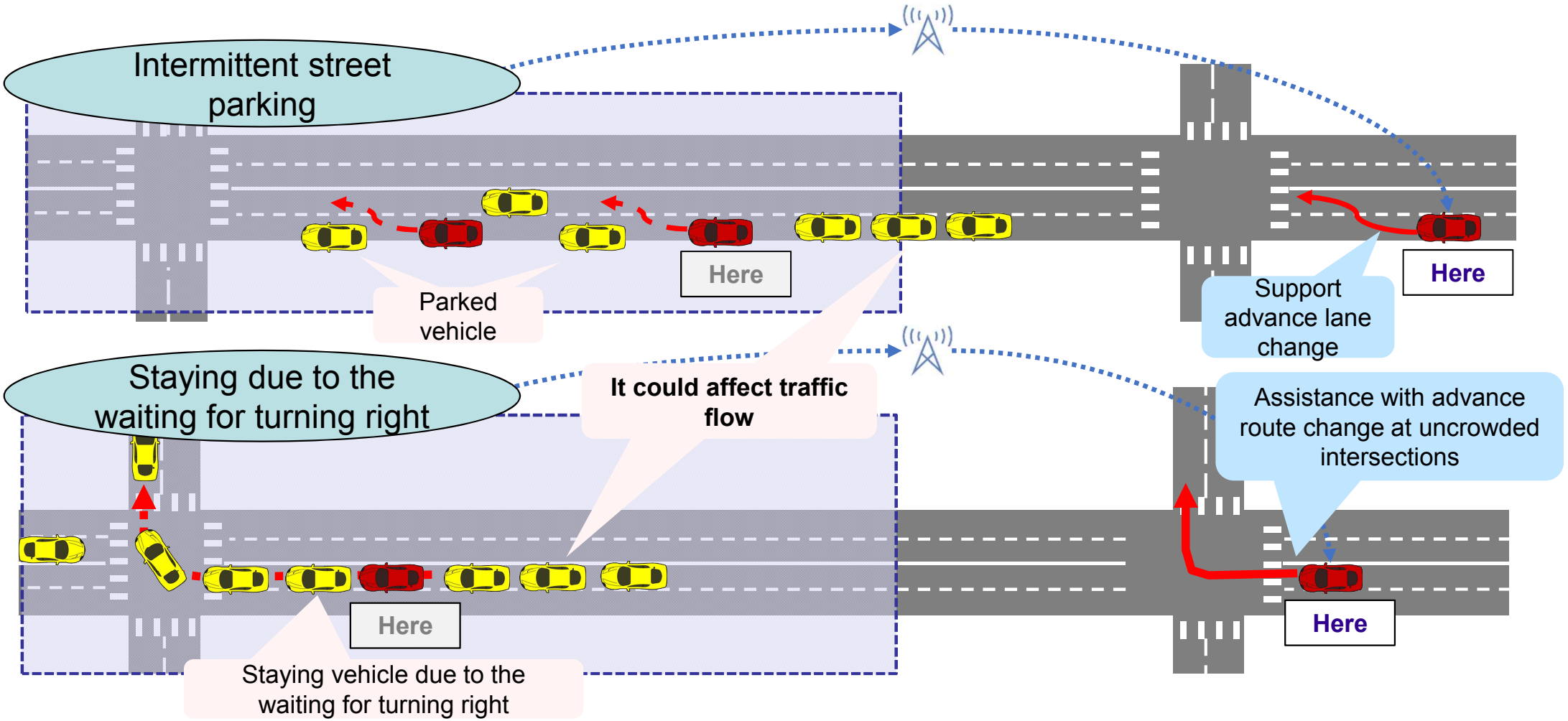
Continuously distribute the situation in front of the automated driving vehicle (for several blocks) as information for supporting advance lane change and route change of the vehicles

Before

By lane change due to the influence of parked vehicles and staying in a crowded intersection, it may hinder traffic flow in the surrounding area

After

Support advance lane change and route change of automated vehicles by continuously distributing the **situation on the front side,** and achieve smooth traffic flow



Output

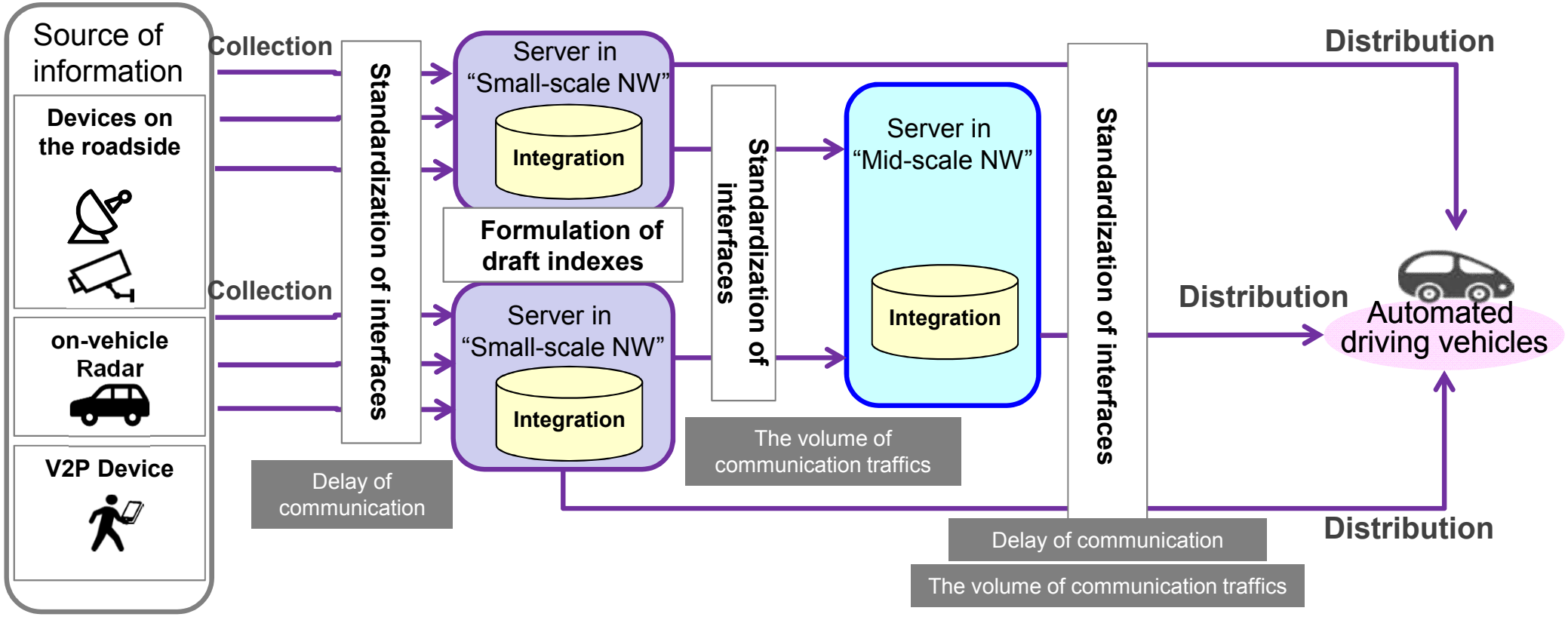
Collecting and integrating information from multiple sources

- **Standardize interfaces** such as format of collected data and protocol between each information source and server in Small-scale NW, and between each NW in Small-scale NW/ Mid-scale NW
- **Considering and organizing the conditions for integrating information, and formulating draft indexes**

Distribution of information to automated driving vehicles

- **Formulate an information distribution method** so that the information distributed from the NW side **can be shared with the information on the vehicle side**

→**Use the results of this R&D to standardize the collection and distribution interfaces and guideline integrated indexes**



System configuration proposed in the R&D（Small-scale NW）

- Acquisition and integration of information by multiple sensors is necessary to grasp traffic conditions inside intersections and in blind spots
- Utilize information from sensors on the infrastructure and that installed in vehicles. If necessary, a new sensor will be installed at an important point / location
  → Select the implementation method of extraction / integration processing of target information, and the communication method suitable for it. **Verification is conducted by 2 methods.**

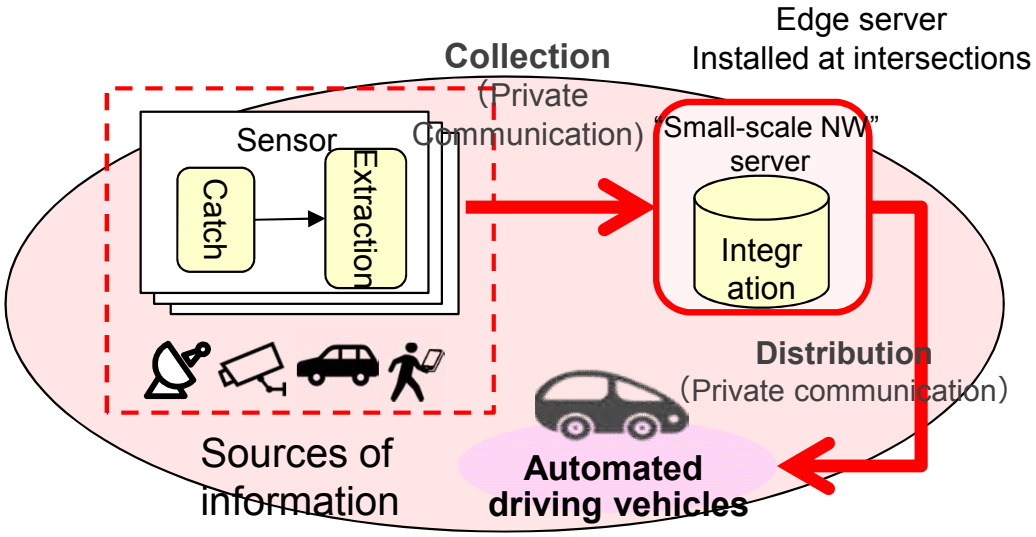
Private Communication:
Direct communication without using public communication base station (DSRC, LTE V2X(PC5) , WiGig)

Mobile Communication：
Communication utilizing cellular network（5G＋LTE）

“Small-scale NW” method ①Processing on the rode side

Extract target information on the side of information sources, and integrate it in the edge server on road side *Utilize private communication when collecting and distributing

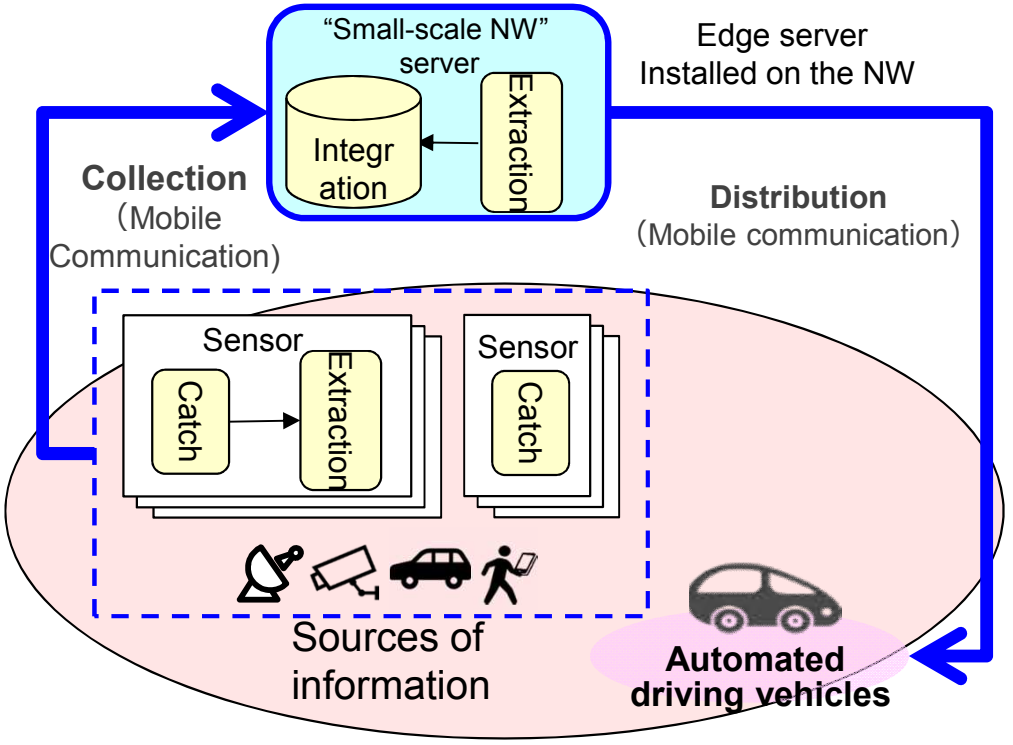
*Oki Electric Industry, Panasonic is responsible



“Small-scale NW” method ②Processing at the center

Distributing sensing information caught on the side of information sources directly to the edge server on NW side, then extract and integrate target information on the server side
（Some information is extracted at the information sources）
*Utilize Mobile communication when collecting and distributing

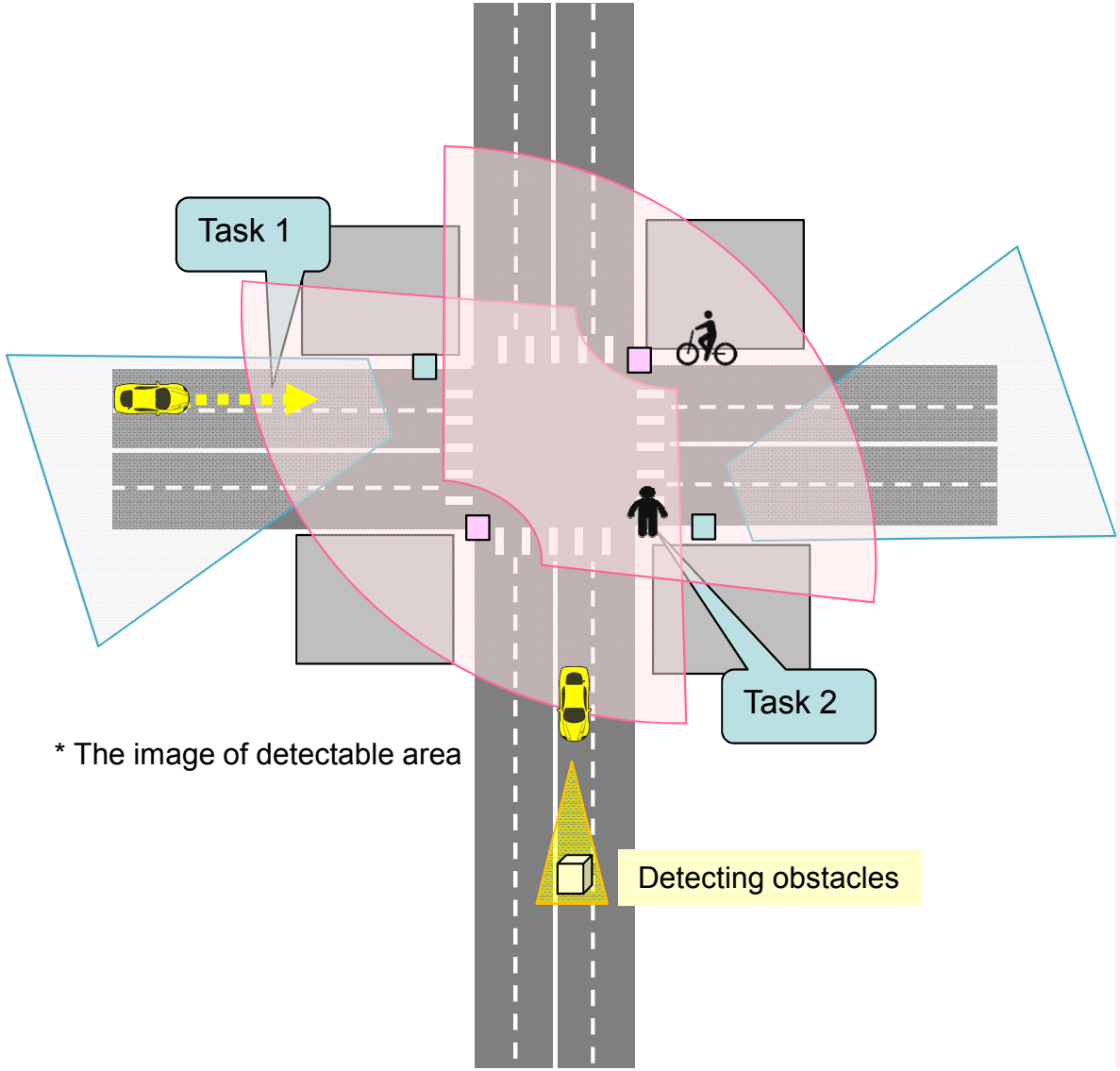
*Sumitomo Electric Industries is responsible



Main problem and points for solution（Small-scale NW）

-Draft indexes for integrating the collected information-

- In Small-scale NW, **multiple sensors or different types of sensors** that could be information sources will be out of time or location
- That's why ①Seamless detection across the sensor detectable areas, ②Identical judgment of target information detected by different sensors, will be important
  →Conduct **R&D focused on the integration / identification technology**



* The image of detectable area

＜Task concerning integration＞

●Integration in each detectable area

Integrating different detectable areas inside intersections and on the surrounding roads

→**Task ① :**

Seamless detection across sensing detectable areas

●Integration of different sensors which can detect the same areas

Integrating the attribute information of different sensors

→**Task ② :**

Identification of target information detected by *different sensors

*Included, but not limited to road side sensors, ITS devices (pedestrian, car, bicycle)

＜Issues for problem solving＞

●"Out of time" issue :

Considering the method for time synchronization

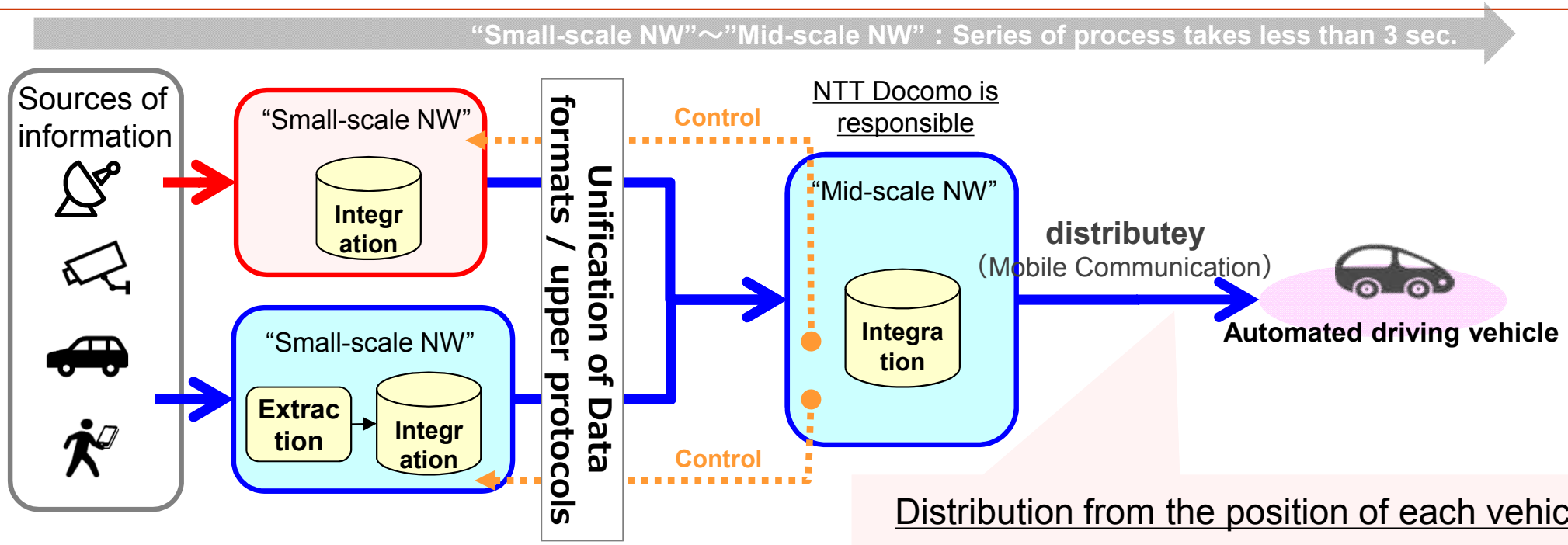
●"Out of place" issue :

Considering the method for identification utilizing the correlation of behaviors（The correlation of trajectory of targets, direction, multiple targets）

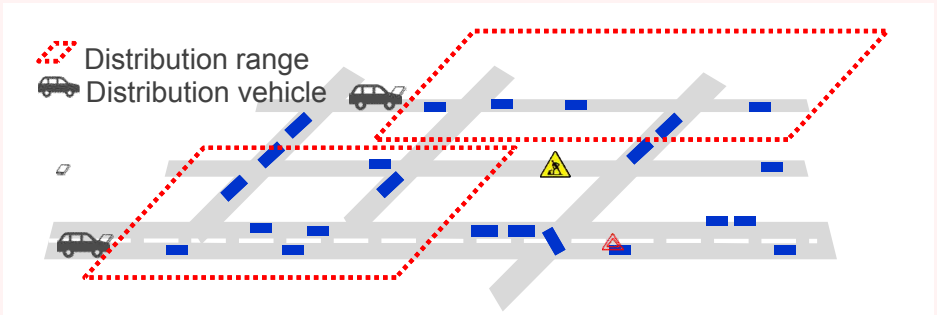
System configuration proposed in this R&D（Mid-scale NW）

We propose the following configuration as a system that realizes the overall image of R&D

- In Mid-scale NW, introduce the method which allows to be connected from each Small-scale NW with common IFs (data formats / protocols) and to control information types collected and how often to collect from each Small-scale NW
- **Distribute continuously, and frequently traffic conditions for several blocks in front of the vehicle** so that it is processed easily on the both side of the destination vehicles



Distribution from the position of each vehicle



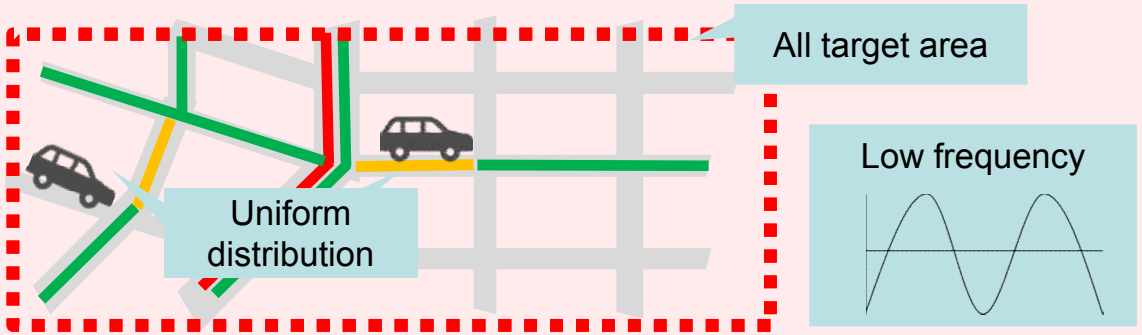
Main problem and points for solution（Mid-scale NW)

- In Mid-scale NW, information collected from multiple Small-scale NW is processed, and distributed to vehicles
- In a series of processing above, this R&D especially focuses on the technology that appropriately grasps the location information of the destination vehicle, and **variably distributes information, from the position of each vehicle**

Characteristics of the distribution technology in the “Mid-scale NW”

【Existing ITS】

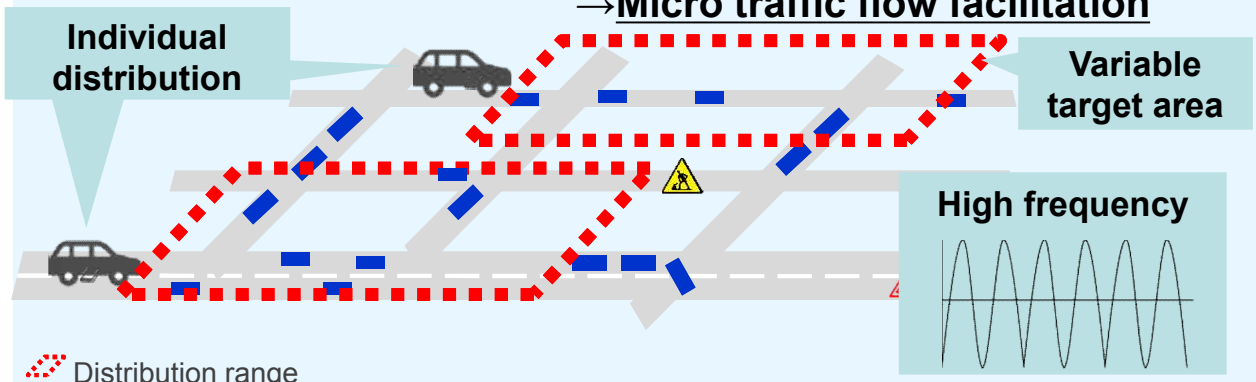
Distribute wide area traffic information (congestion information, etc.)
→Macro traffic flow facilitation



Method suitable for distribution of traffic information in wide area (congestion information, etc.)

【Method proposed】

Distribute dynamic information for several blocks in front of the vehicle
→**Micro traffic flow facilitation**



If it is applied directly to the support assumed this time, **the increase of traffic volume, and high load on distribution servers / receiving terminal side** could be a problem

By variably distributing information, from the position of each vehicle, **traffic volume is decreased, and the load on distribution servers / receiving terminal side is mitigated**

■ Performance in FY2019

- Specific use case study and collaboration system study
- Arrangement of R&D preconditions and constraint conditions for evaluation and verification, and test environment design
- Individual hearings with related ministries, public agencies and the Japan Automobile Manufacturers Association, and Holding of R&D Steering Committee

  →Getting opinions / advice on R&D from experts

■ Plan for FY2020

- Build an environment for verification of actual equipments and proceed with verification by desktop studies / simulations by the first quarter of FY2020.

  Integrated demonstration is planned after verification.
- Continue Individual hearings and Holding of R&D Steering Committee
- Conduct comprehensive confirmation and evaluation the third quarter of FY2020 at latest