SIP-adus Workshop 2022

Dynamic Map

TF3-22-116 III6

FOTs in the Tokyo Waterfront Area
Overview of FY2021-2022 V2N FOTs results

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SIP

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1. Overview of the FOTs in the Tokyo Waterfront Area

- In preparation for the expansion of ODDs for advanced driving assistance and automated driving, the following FOTs were performed
  - (1) Establishment of static information platform (FY2017-2018)
  - (2) Evaluation of effectiveness of dynamic information (FY2019-2020)
  - (3) Evaluation of availability of public networks (V2N) (FY2021-2022)

This report

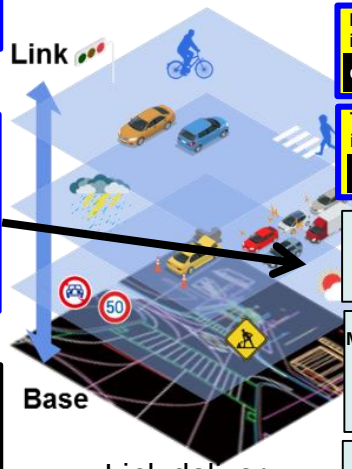
(3) SIP Phase 2 FOTs in the Tokyo Waterfront Area (FY2021-2022)
- Provided four types of traffic environmental information using V2N
- Verified effectiveness of various traffic environmental information

Expansion of information types

(2) SIP Phase 2 FOTs in the Tokyo Waterfront Area (FY2019-2020)
- Provided traffic environmental information (traffic signal information, merging support, ETC gate passing support information) via V2I
- Established effectiveness of dynamic information

Superposition of static and dynamic information

(1) SIP Phase 1 Dynamic Map (FY2017-2018)
- Deliberation regarding dynamic map concept and high-accuracy 3D map, prototyping, and evaluation
- Consensus regarding cooperative area high-accuracy 3D map specifications



Link delivery

Rainfall information
General road | Highway

Lane-specific road traffic information
Highway

Emergency vehicle location information
General road | Highway

Traffic signal prediction information (V2N)
General road

V2N

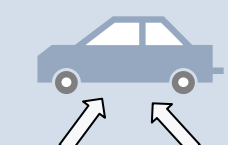
Traffic signal prediction information (V2I)
General road

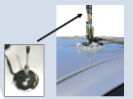
Merging/ETC gate support information
Highway

High-accuracy 3D map
General road | Highway

V2I

Mobile router





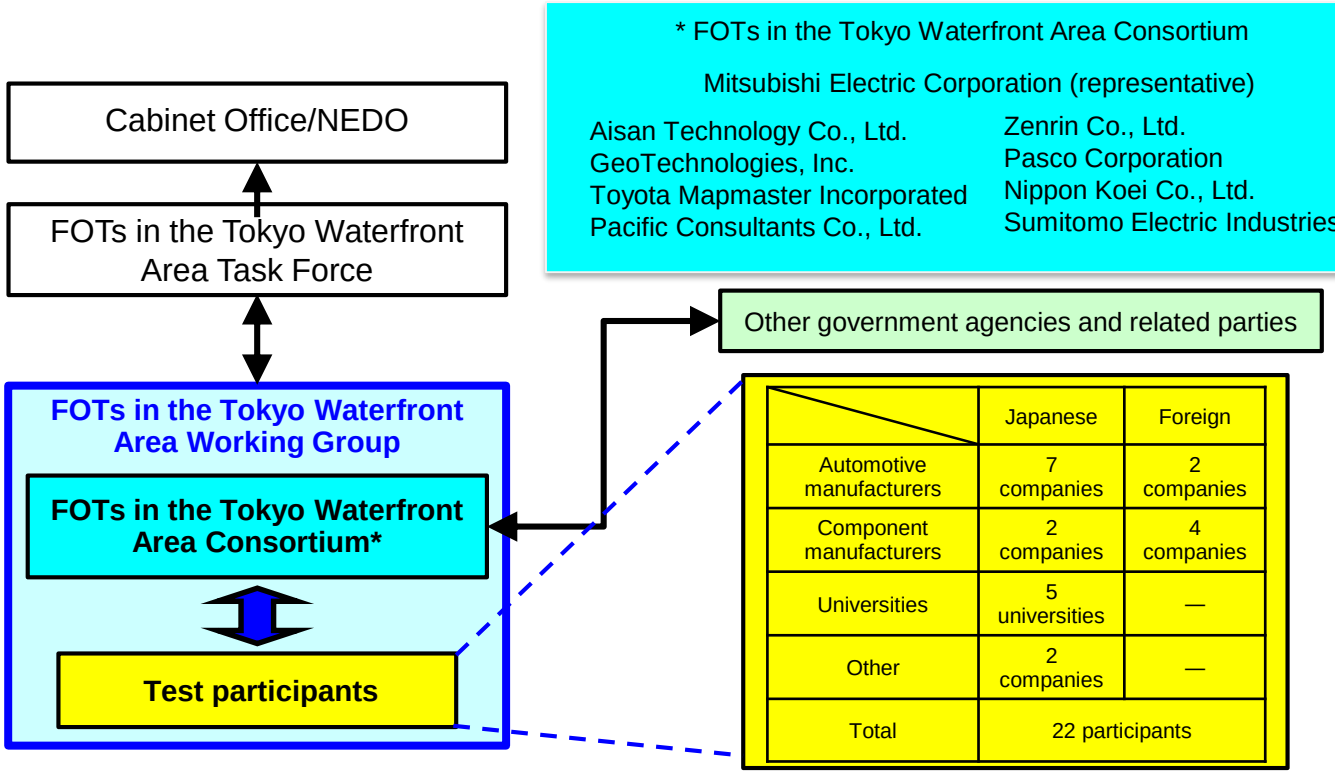
ITS wireless receiver for providing traffic signal information

ETC2.0 test vehicle on-board equipment

1. Overview of the FOTs in the Tokyo Waterfront Area

(1) Implementation structure

- Carried on test structure used in FY2021
- Total of 22 participants, including foreign and domestic automotive manufacturers, component manufacturers, universities, and venture companies

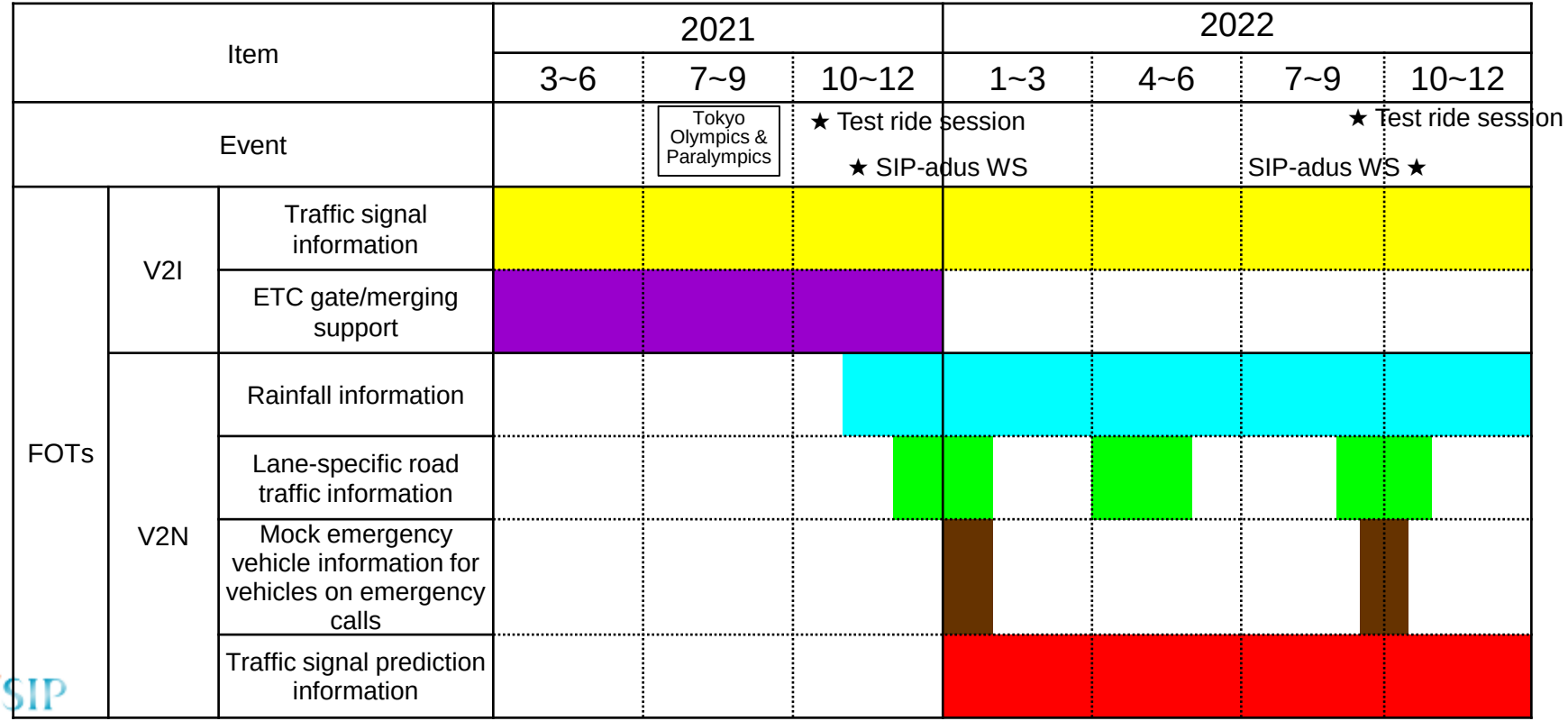


	Japanese	Foreign
Automotive manufacturers	7 companies	2 companies
Component manufacturers	2 companies	4 companies
Universities	5 universities	—
Other	2 companies	—
Total	22 participants	

1. Overview of the FOTs in the Tokyo Waterfront Area

(2) Testing schedule

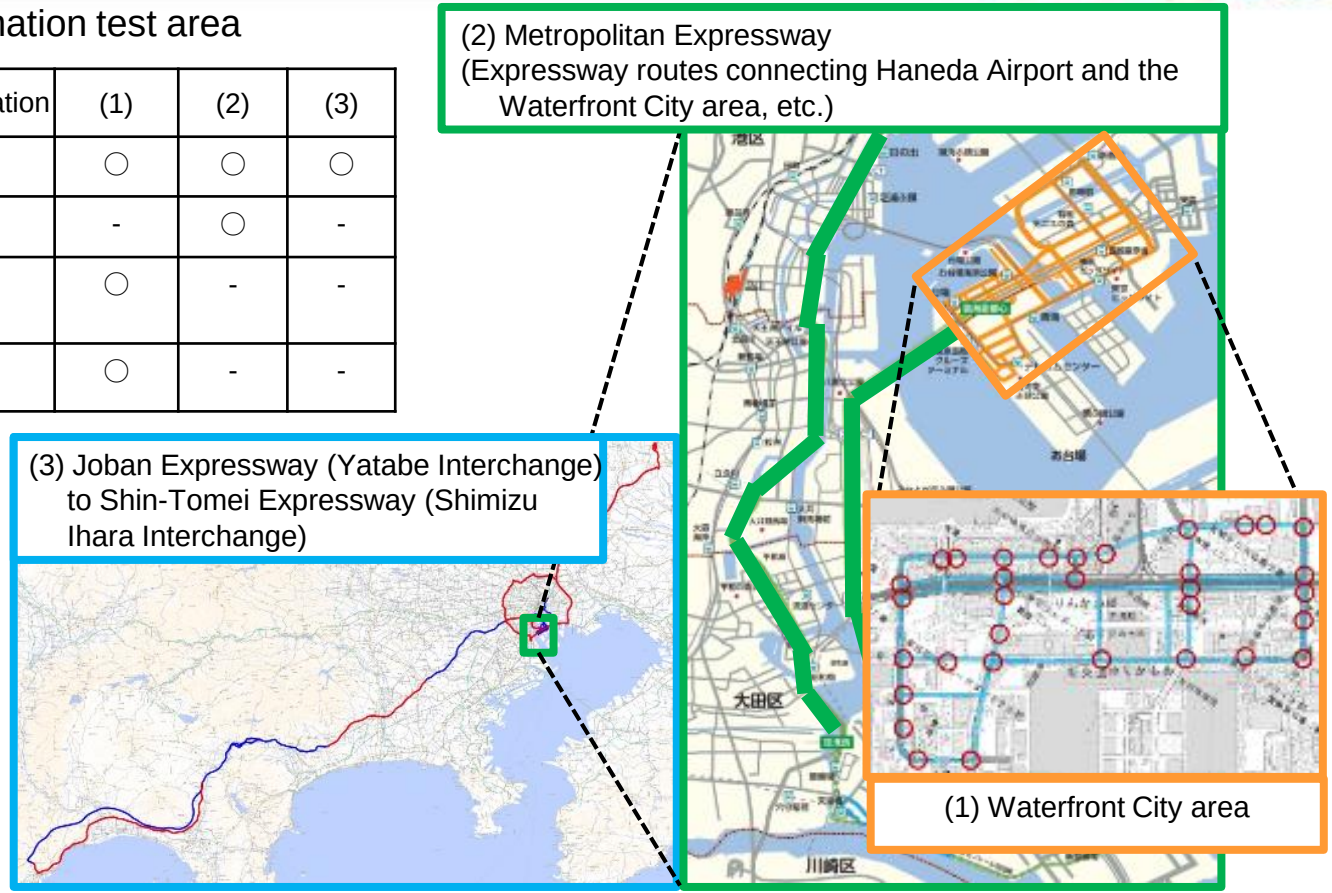
- V2N FOTs are being conducted from November 2021 to December 2022



1. Overview of the FOTs in the Tokyo Waterfront Area

(3) Traffic environmental information test area

Test area and traffic environmental information	(1)	(2)	(3)
Rainfall information	○	○	○
Lane-specific road traffic information	-	○	-
Mock emergency vehicle information for vehicles on emergency calls	○	-	-
Traffic signal prediction information	○	-	-



https://maps.gsi.go.jp/#12/35.632884/139.810982/&base=pale&ls=pale&disp=1&vs=c0j0h0k0l0u0t0z0r0s0m0f0

Source: Geospatial Information Authority of Japan map (acquired on September 28, 2021)

* Created using Geospatial Information Authority of Japan light color map

1. Overview of the FOTs in the Tokyo Waterfront Area

(4) Summary of participant driving plans and driving results (including predictions): Approx. 57,424 km
- March 1, 2021, to November 15, 2021 (V2I): Approx. 31,617 km
- November 16, 2021, to December 23, 2022 (V2I + V2N): Approx. 25,807 km

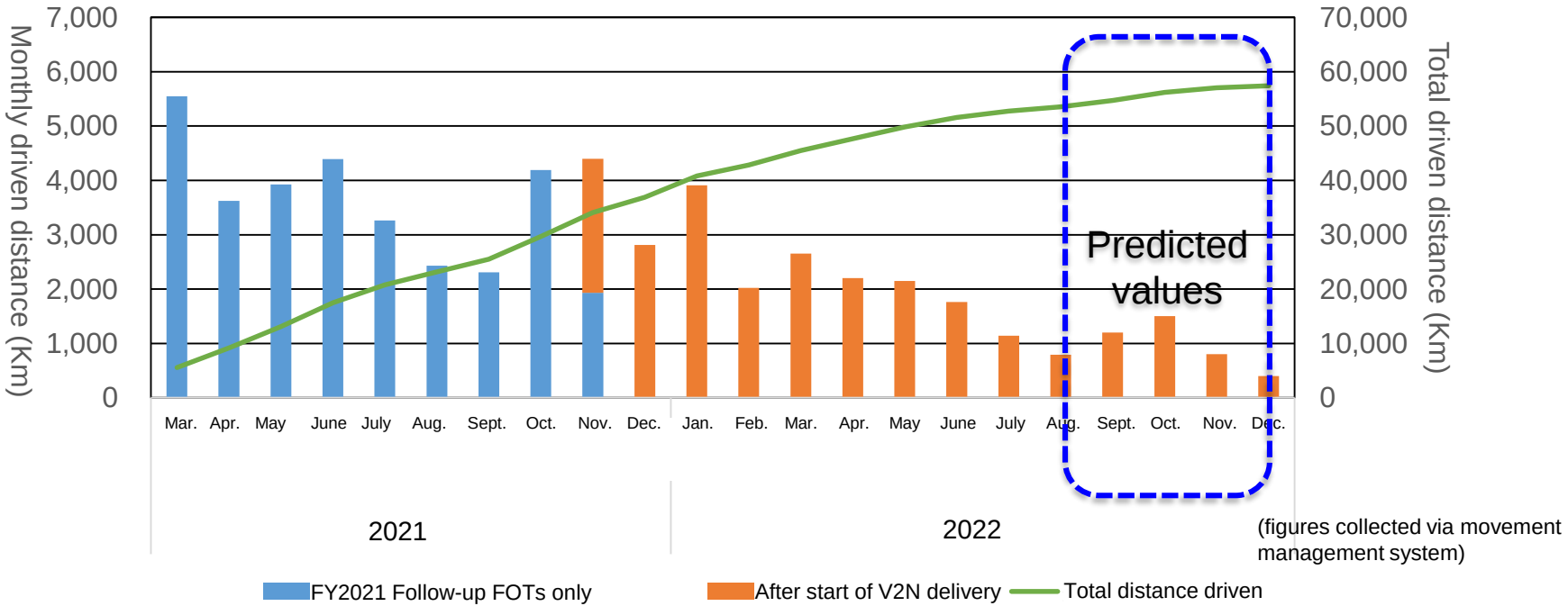


Figure 2.1 Participant driving results to date (including predicted future driving results)

2. Architecture and evaluation of the V2N information delivery system

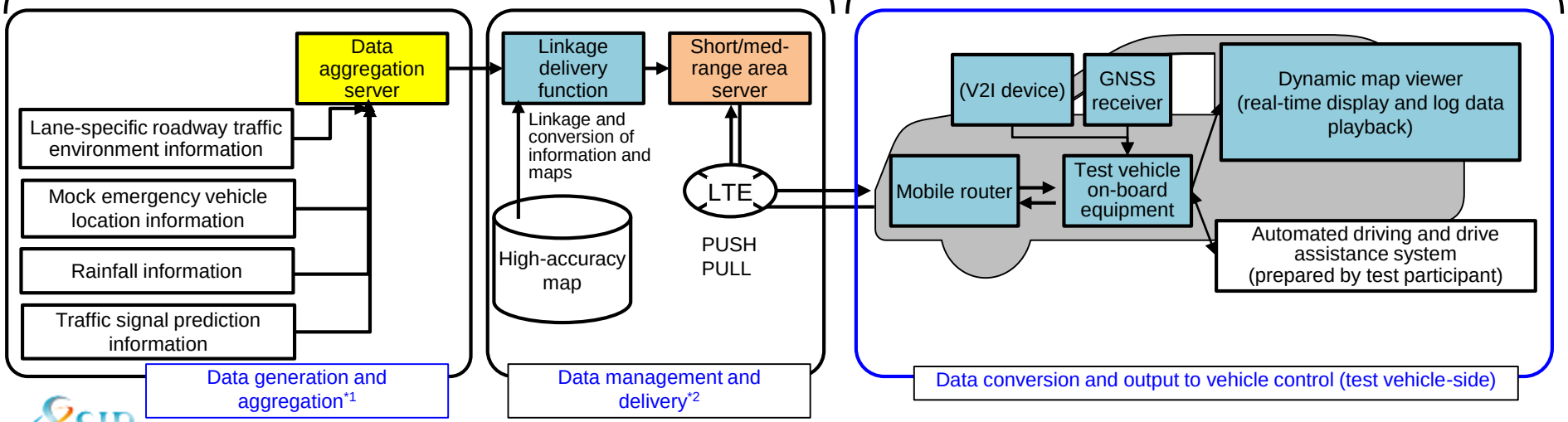
(1) Evaluation approach and test system configuration

Equipment-side evaluation

Build a new traffic environmental information V2N delivery environment and identify issues involved in societal deployment: Coordination between three contractors

Test participant evaluation

Verify effectiveness of traffic environmental information for automated driving systems and drive assistance systems

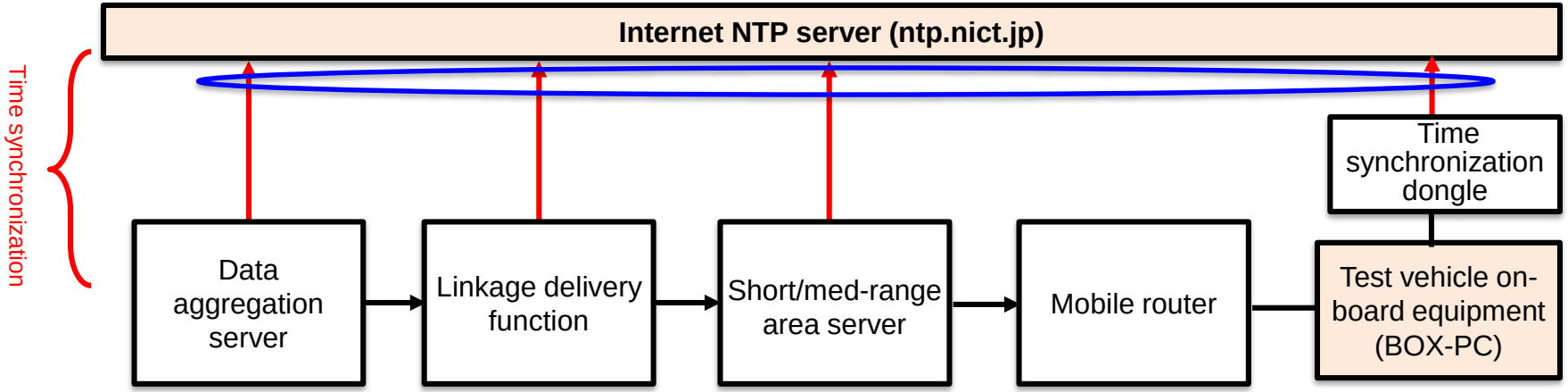


*1:Handled by "Examination and Evaluation of Automated Driving Control Technologies that Use Lane-specific Probes, etc." contractors
*2:Handled by "Research and Development on the Collection, Integration, and Delivery of Short-range and Medium-range Information" contractors

2. Architecture and evaluation of the V2N information delivery system

(3) Characteristics of FOTs system transmission delay (test system calibration)

- Device times were synchronized with an NTP server on the internet to achieve an average transmission delay of approximately 1.6 ms (max. ± 20 ms)



Device	Deviation (- ahead, + behind)	Flow of data
Data aggregation server	-47 μs to 52 μs	PUSH/PULL
Linkage delivery function	-3.17 ms to 0.6 μs	PUSH/PULL
Data distribution server	-1.72 ms to 16.4 ms	PUSH
Test vehicle on-board equipment	-14.8 ms to 16.4 ms	PUSH/PULL

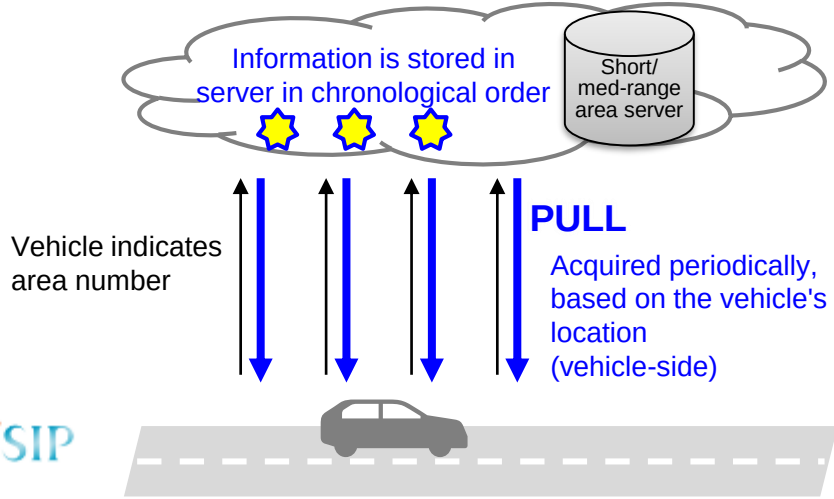
2. Architecture and evaluation of the V2N information delivery system

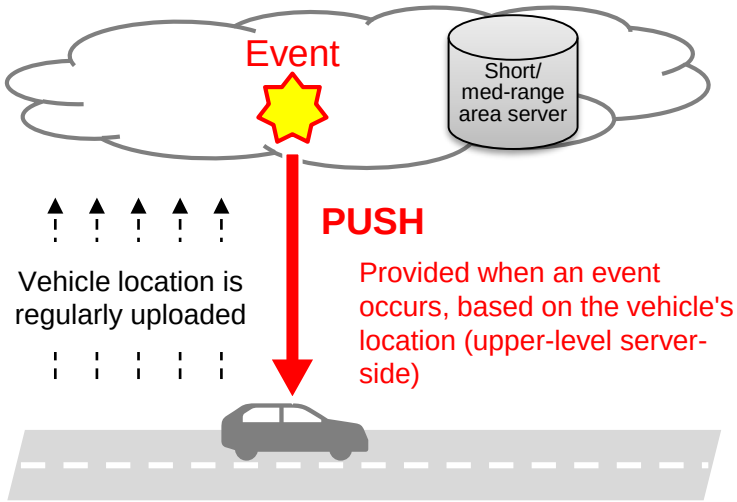
(2) Delivery of traffic environmental information using PUSH and PULL methods

- Information delivery methods for efficiently extracting information from the cloud
  ⇒ Consider how to reduce transmission delays related to transmitted traffic and network transmission

PULL method: High volume, low frequency information updates
✓ Rainfall information
✓ Lane-specific road traffic information

PUSH method: Low volume, high frequency information updates
✓ Mock emergency vehicle information for vehicles on emergency calls
✓ Traffic signal prediction information

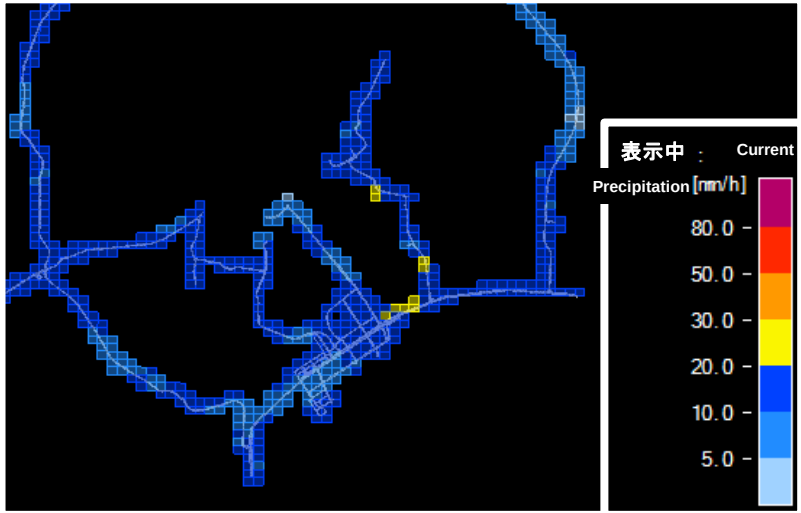


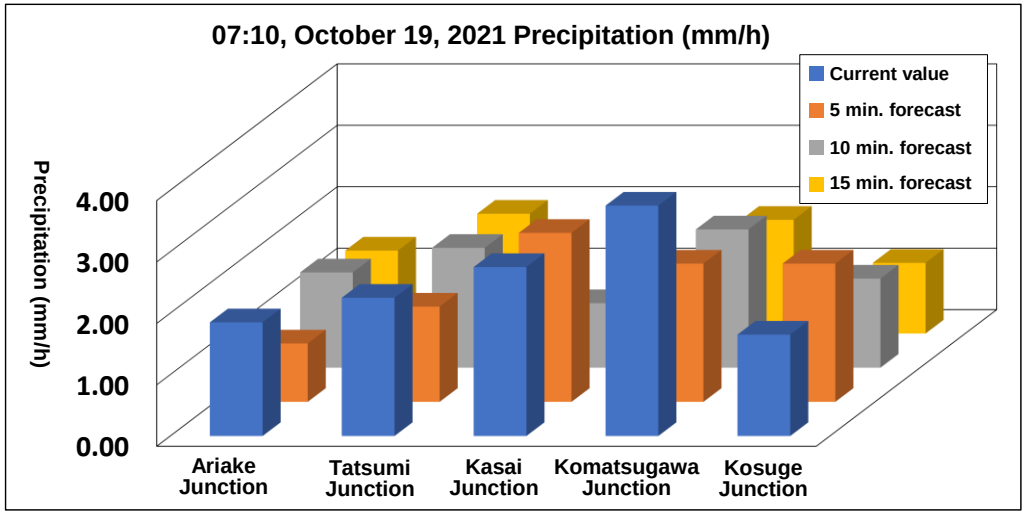


3. Features of the V2N information delivery system

(1) Characteristics of rainfall information

- Information is provided in 5 minute intervals
- This information can be used for handover between automated driving and manual driving and to provide caution information to the driver



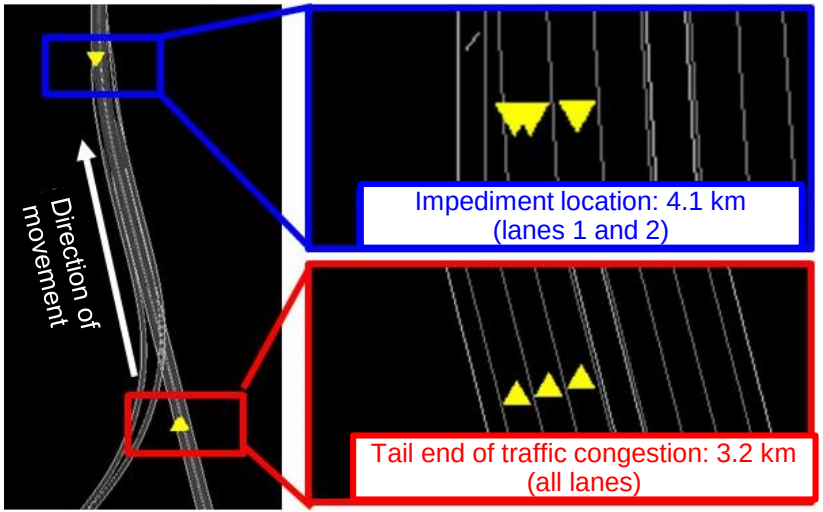


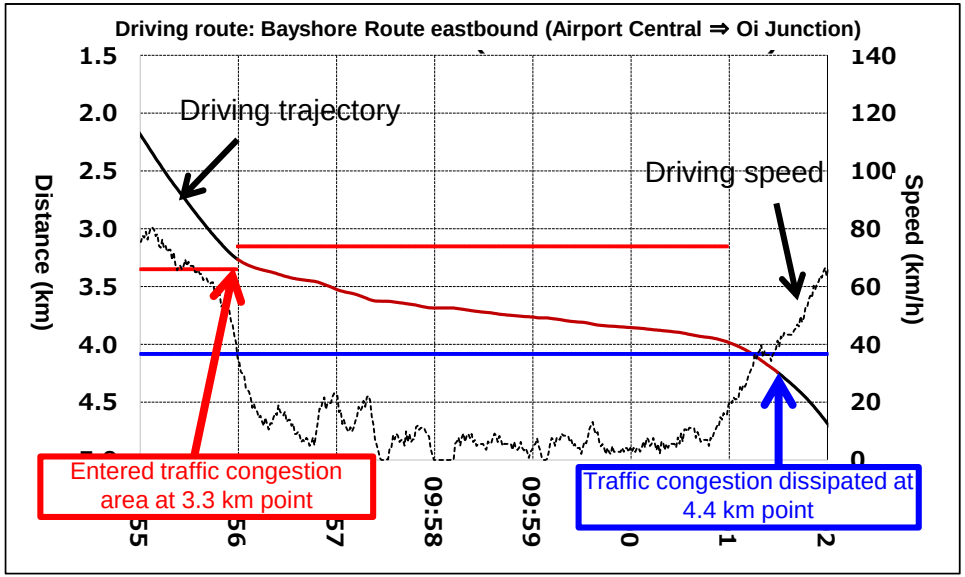
Information source: Japan Meteorological Business Support Center
Provided information: High-resolution Precipitation Nowcasts or High-resolution Precipitation Nowcasts (5 minute precipitation amount), current condition analysis and 30 minute forecasts issued every 5 minutes

3. Features of the V2N information delivery system

(2) Characteristics of lane-specific road traffic information

- Information is provided in 1 minute intervals, but the data that is delivered is generated every 5 minutes from probe information
- The test vehicle reached the tail end of the traffic congestion and then slowed down and continued driving. The traffic congestion dissipated and the vehicle accelerated and passed the area.



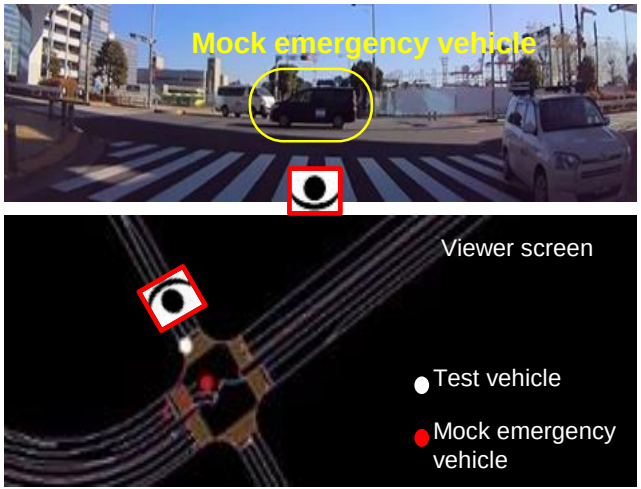


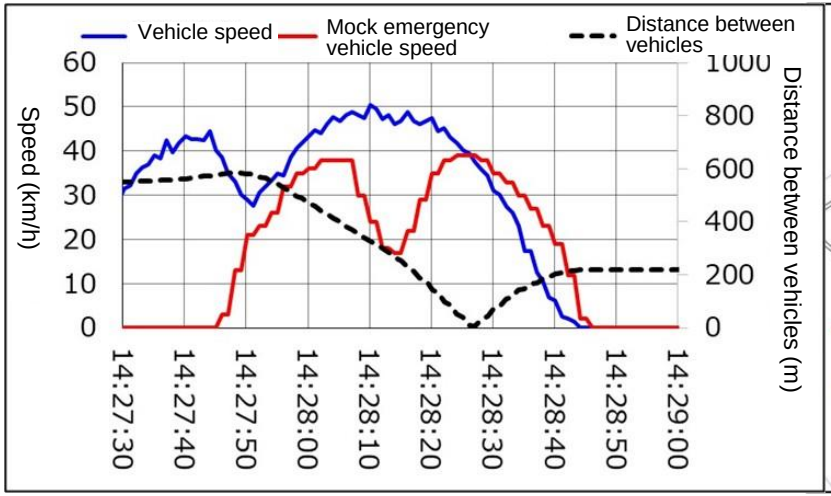
Information source: Probe information (OEM/car navigation equipment manufacturer)
Provided information: Traffic congestion tail end location information for forking and merging areas, location information for locations of driving impediments, such as accidents or start of traffic congestion

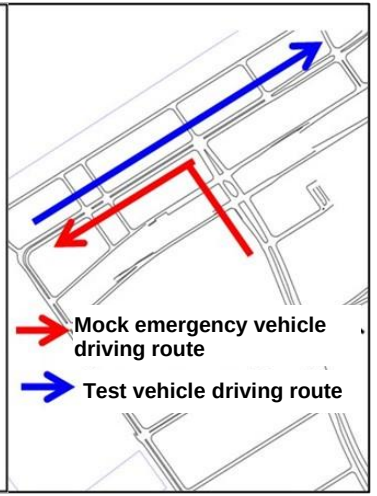
3. Features of the V2N information delivery system

(3) Characteristics of mock emergency vehicle information for vehicles on emergency calls

- Vehicle location information in 1 ms increments is provided every 2 seconds
- The graph below shows the distance between the test vehicle and the mock emergency vehicle on an emergency call that passed each other and their speed characteristics
- It would be worthwhile to deliberate regarding use cases and vehicle behavior in preparation for future real-world deployment







Information source: Mock emergency vehicle
Provided information: Location information for emergency vehicle updated every 100 ms, distributed every 2 seconds

3. Features of the V2N information delivery system

(4) Characteristics of traffic signal prediction information

- Traffic color information for each traffic signal was generated and shared three seconds before the light turned green
- Evaluation was performed using the following test methods, envisioning future real-world deployment

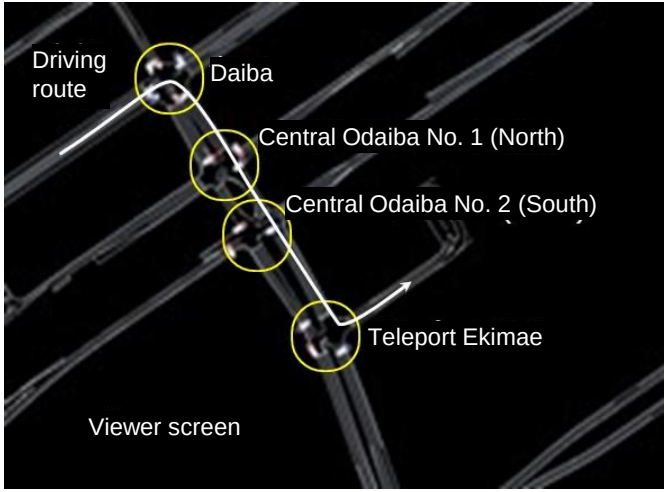
Method	Characteristic
PUSH method	✓ Vehicle location information is provided to the short-range and medium-range area server in the data management and delivery section ✓ Traffic signal information for intersections in the area around the test vehicle are provided to the vehicle in 1 second intervals
PULL method	✓ Traffic signal information for intersections in the area around the test vehicle are requested by and provided to the vehicle in 1 minute intervals
Specified intersection PUSH method	✓ Traffic signal information for intersections along driving routes are requested from the short-range and medium-range area server in the data management and delivery section, and the information is provided in 1 second intervals

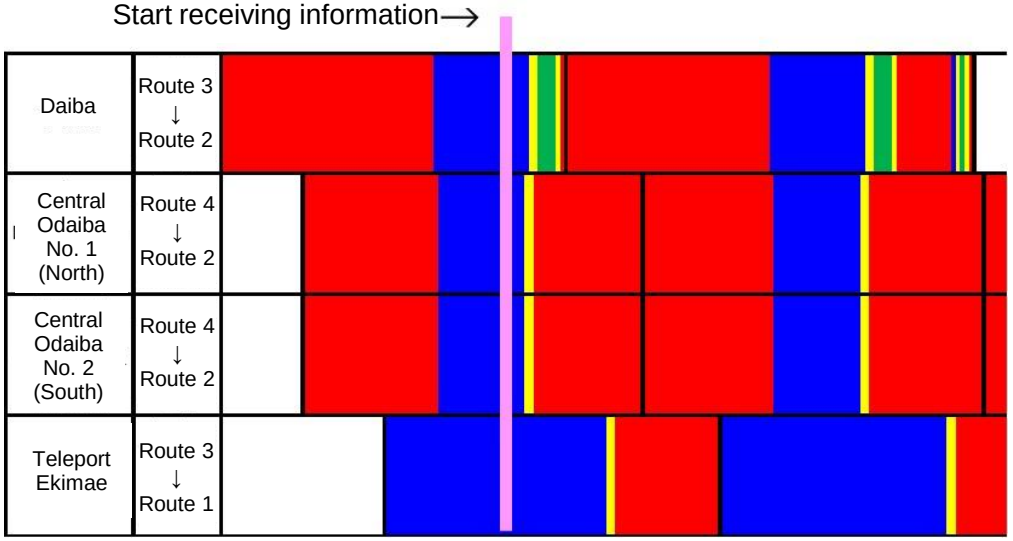
- Optimal methods were determined through testing

3. Features of the V2N information delivery system

(4) Characteristics of traffic signal prediction information

- Specified intersection PUSH method
- Traffic signal color information when traffic signal prediction information was requested from the four intersections in the figure just before reaching the Daiba intersection
- Traffic signal information for multiple intersections along the driving route can be ascertained at the same time
- Effective for selecting optimal driving routes





Information source: Metropolitan Police Department
Provided information: Traffic signal color prediction information when traffic signal cycle is confirmed. In this test, the information was generated and supplied three seconds before the traffic signal prediction information start time
The provided traffic signal prediction information contained the cycle start time (the time when the major road's traffic signal turned green) and light color information for two cycles for each exit direction of each entry route

3. Features of the V2N information delivery system

(5). Characteristics of delivery delay times of road traffic environmental information (summary)

- The delivery delay times for each type of traffic environmental information were as shown below

Traffic environmental information	Delivery delay characteristics
Rainfall information	✓ There is a roughly 10 second delay in the receiving and sending of rainfall information by the data aggregation server ✓ Rainfall information delivery delay time is between 10 and 130 seconds ✓ Japan Meteorological Business Support Center data is delivered in 5 minute intervals, so there is no problem
Lane-specific road traffic information	✓ The delay time, including the test vehicle on-board equipment processing delay, is up to 66 seconds ✓ This is roughly equivalent to the information source delivery cycle length, so there is no problem
Mock emergency vehicle information for vehicles on emergency calls	✓ The maximum delay time is 1.3 seconds ✓ If the cycle length of emergency vehicle information for vehicles on emergency calls is reduced from 2 seconds to 1 second in the future, it will be important to deliberate about how to reduce the delay time to 1 second or below. However, if vehicles learn in advance that an emergency vehicle is approaching, this delivery delay is not expected to have an impact.
Traffic signal prediction information	✓ Due to the use of the specified intersection PUSH method, the delay time is roughly 100 ms

4. International cooperation

(1) International cooperation

- As part of its efforts to support SIP international cooperation, the Consortium participated in the SIP-adus Workshop 2021 Breakout held in November 2021 and took part in deliberations with European participants regarding ADASIS[*1] specifications.
- The Consortium closely considered the submitted ADASIS v3.2 specifications and used the equipment from the Tokyo Waterfront City FOTs and the Waterfront City area itself to perform verification testing of the ADASIS specifications in May 2022.

- ADASIS is notable for using information provided via V2N along with high-accuracy 3D map data stored on the vehicle side to select optimal routes and perform optimal driving.

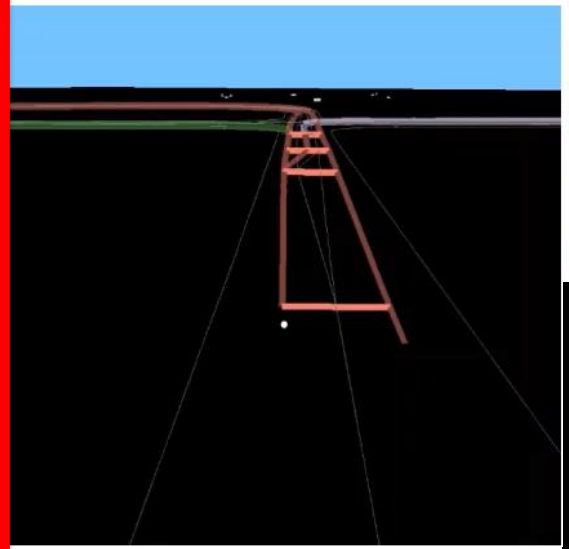
- It would be best to also consider application and use in driving assistance/automated driving systems
- Ongoing opinion-sharing with European ADASIS members is also necessary and beneficial.
- The linking of maps and information, which ADASIS is investigating, is a similar concept to the dynamic map concept created and verified by SIP.

*1:Advanced Driver Assistance Systems Interface Specification

4. International cooperation

(2) European ADASIS verification test

Viewer（Path display）



Viewer（Bird's-eye view display）

Driving recorder

- The system selects optimal routes as the vehicle moves towards the destination (GOAL) and the vehicle drives the selected routes while making holistic decisions based on traffic signal color information and traffic conditions

Application examples

- Navigation system function for searching for optimal routes
- Changing driving routes while en route to reflect information such as traffic signal color information

- the test vehicle

colors on the road：Driving route candidate

5. Conclusion

- An information transmission system that used a public wide-area network (V2N) was set up in the Waterfront City area
- Delivery testing was performed for rainfall information, lane-specific road traffic information, mock emergency vehicle information for vehicles on emergency calls, traffic signal prediction information, and the like
- The delivery system and the use of information was evaluated, issues were identified, and the effectiveness of the system and information were verified

- Based on the issues identified through these FOTs and the results of the effectiveness evaluation, use cases should be clarified, discussions should be held regarding situations where delivered traffic environmental information can be utilized, and progress should be made in the real-world deployment of this information

Thank you