

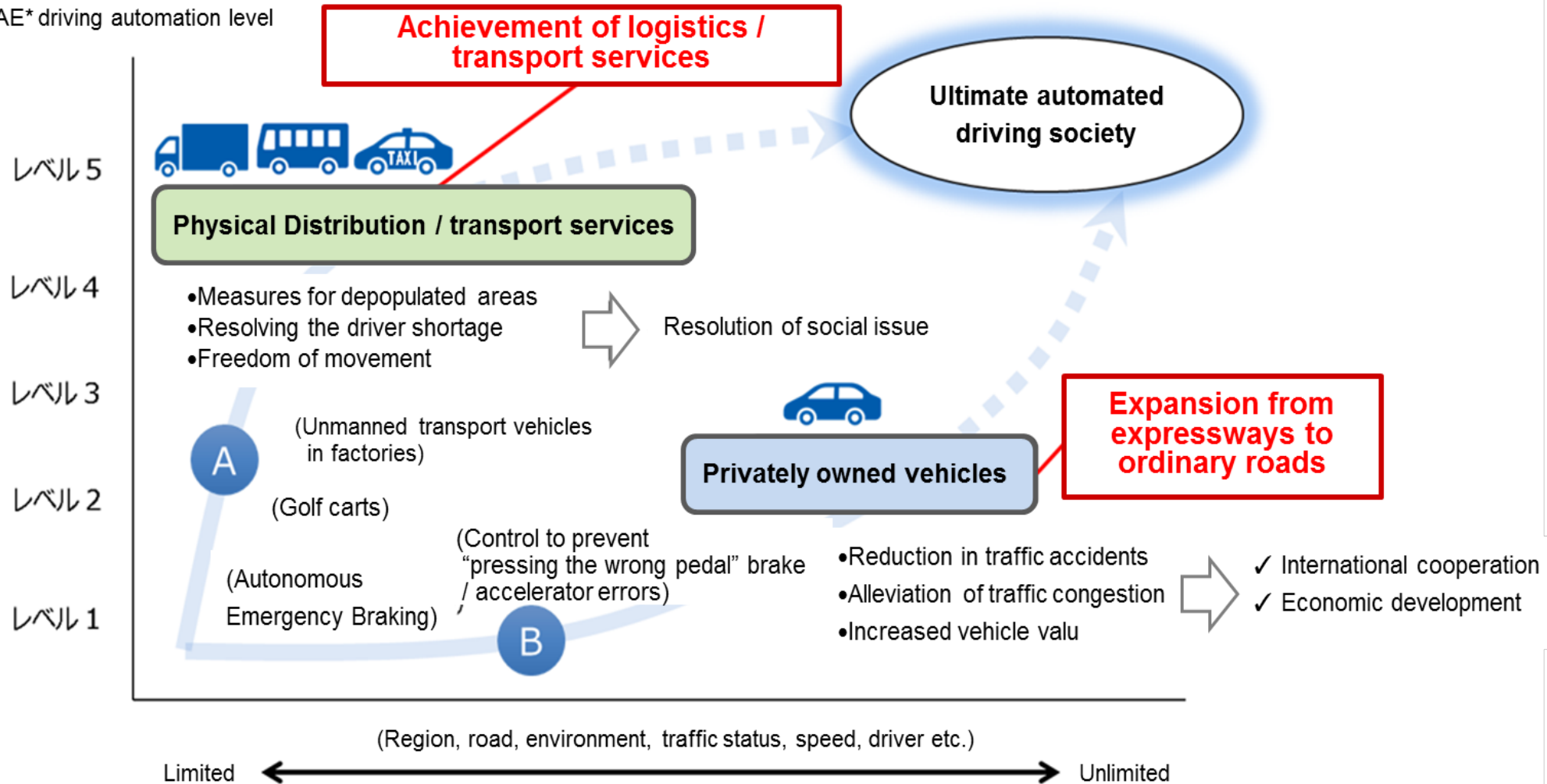
AASHTO

Design and land-use of road space in the automated driving society

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SAE* driving automation level



* SAE: Society of Automotive Engineers (U. S.)

Types of roads	Categories	Government Goals	Rationales
Expressways	Truck platooning	- Commercialization of driverless platooning by 2022	Lack of truck drivers due to aging
	Owner cars	<ul style="list-style-type: none"> - Level 3 by 2020 - Level 4 by 2025 	Heavily relies on private firms efforts
General Highways	Public transportations in the designated routes	<ul style="list-style-type: none"> - Implementation Level 4 in society by 2020; - Disperse of Level 4 by 2025 (around 100 site all over Japan) 	Lack of transportation ways due to an decrease in population in rural areas

Vehicle standards Road Transport Vehicle Act

Imposed new regulations for “**automated driving equipment**”

- Added to items that are subject to safety standards;
- When used under conditions imposed by the Minister of Land, Infrastructure, Transport and Tourism; and,
- Equipment that contains apparatuses with functions to take over all capabilities relating to recognition, prediction, judgment and operation pertaining to steering of the vehicle by a human being, and an apparatus to record data

Traffic rules Road Traffic Act

A portion of the regulations that must be observed when operating a vehicle using automatic driving equipment have been relaxed (assuming Level 3).

Conditions for use

- Use conditions imposed by the Minister of Land, Infrastructure, Transport and Tourism
- Must be able to reliably operate the vehicle even when use conditions are not fulfilled or equipment failure has occurred

Content that has been relaxed

- Use of mobile phones and screen viewing

ODD (Operational Design Domain) combination of the following conditions

- Road conditions (expressway or ordinary road, vehicle-only road or mixed traffic environment, number of lanes, presence of lanes etc.)
- Geographical conditions (urban area or depopulated area, etc.)
- Environmental conditions (weather, daytime or nighttime etc.), and others

A variety of FOTs implemented all over Japan

Self-driving vehicle mobility services in regional areas (MLIT / Cabinet Office SIP)

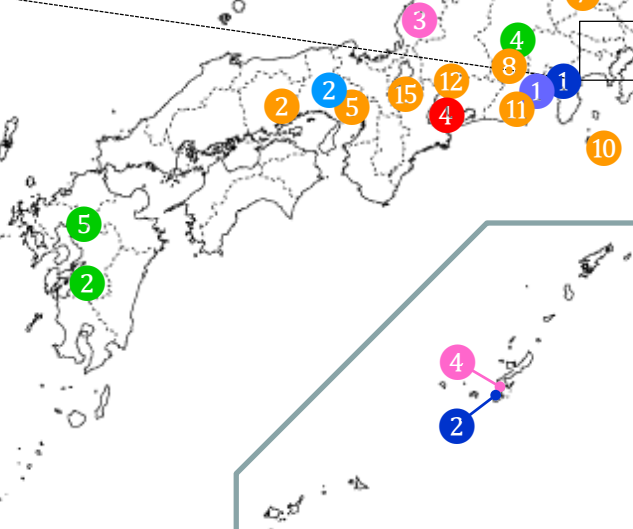
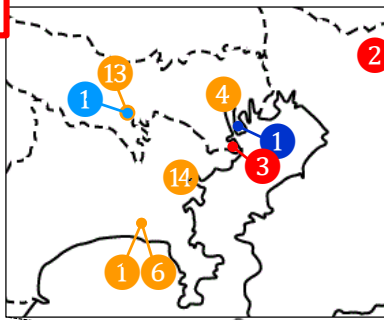
Cross-ministerial Strategic Innovation Promotion Program (SIP), etc. (Cabinet Office)

Last One Mile automated driving (METI & MLIT)

1	December 2018 – February 2019 Kamikoani Village, Akita Pref. 道の駅「かみこあに」
2	January – March 2019 Ashikita-machi, Kumamoto Pref. 道の駅「芦北でこぼん」
3	May – June 2019 Taiki-cho, Hokkaido 道の駅「コスモール大樹」
4	November 2018 Ina City, Nagano Pref. 道の駅「南アルプス長谷」
5	November – December 2018 Miyama City, Fukuoka Pref. みやま市役所 山川支所
6	June – July 2019 Hitachiota City, Ibaraki Pref. 道の駅「ひたちおた」及び高倉交流センター

1	October 2017 – ongoing Expressways in Kanto Region, etc. and ordinary roads in vicinity of Tokyo Waterfront Area 国内外の自動車メーカー、 自動車部品メーカー、大学 等
2	February – March 2019 Okinawa Pref. Naha Airport – Michi-no-Eki Toyozaki JTECT等

1	October 2018 Hitachi City, Ibaraki Pref. 日立市、産総研、SBDドライブ等
2	February 2019 Wajima City, Ishikawa Pref. 輪島市、輪島商工会議所、産総研、 ヤマハ発動機等
3	October – November 2018 Eiheiji-cho, Fukui Pref. 永平寺町、福井県、産総研、ヤマハ 発動機等
4	January – February 2019 Chatan-cho, Okinawa Pref. 北谷町、産総研、ヤマハ発動機等



Cross-ministerial Strategic Innovation Promotion Program (SIP), etc. (Cabinet Office)

1	February 2019 Tama City, Tokyo 日本総研、京王電鉄バス
2	February 2019 Miki City, Hyogo Pref. 日本工営、大和ハウス

Automated driving in airport restricted areas (MLIT)

1	December 2018 Sendai Airport 豊田通商
2	December 2018 – January 2019 Narita International Airport 鴻池運輸、ZMP、丸紅
3	January – February 2019 Tokyo International Airport 愛知製鋼、NIPPO、日本電気、SBD ライブ、先進モビリティ
4	February 2019 – ongoing Central Japan International Airport アイサンテクノロジー、ダイナミック マップ基盤、丸紅、ZMP

Truck platooning (MLIT & METI)

1	November 2018 – February 2019 Shin-Tomei Expressway 豊田通商、 国内トラックメーカー等
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Local governments, private sector and universities (* indicates major FOT)

1	April 2018 Fujisawa City, Kanagawa Pref. ヤマト運輸、DeNA
2	April 2018 Akaiwa City, Okayama Pref. SBDドライブ、宇野自動車
3	April 2018 Fukushima Daiichi Nuclear Power Plant 東京電力、SBDドライブ
4	August 2018 Chiyoda Ward, Tokyo 東京都、日の丸交通、ZMP
5	August 2018 – ongoing Kobe City, Hyogo Pref. 神戸市、日本総研、関電、 電通、NTTデータ、群馬大、沖電気等
6	September 2018 Fujisawa City, Kanagawa Pref. 神奈川県、小田急、SBDドライブ
7	November 2018 Maebashi City, Gunma Pref. 前橋市、NTTデータ、 日本中央バス、群馬大
8	November 2018 Iida City, Nagano Pref. 飯田市、KDDI、アイサンテクノロジー

9	December 2018 – ongoing Ofunato City, Iwate Pref. JR東日本、先進モビリティ、 愛知鉄鋼、京セラ、ソフトバンク、 日本信号、日本電気
10	December 2018 Miyakejima, Tokyo 東京都、アイサンテクノロジー、 群馬大
11	January 2019 Fukuroi City, Shizuoka Pref. 静岡県、袋井市、名古屋大
12	February 2019 Ichinomiya City, Aichi Pref. 愛知県、KDDI、KDDI総研、 アイサンテクノロジー、ティアフォー、 名古屋大、岡谷鋼機、損保ジャパン日本興亜
13	February 2019 Tama City, Tokyo 東京都、神奈川中央交通、SBDドライブ
14	February – March 2019 Yokohama City, Kanagawa Pref. 日産、DeNA
15	March 2019 Otsu City, Shiga Pref. 大津市、京阪バス

Thirteen FOTs in hilly and mountainous areas

Technology verification



Measures for securing dedicated driving spaces



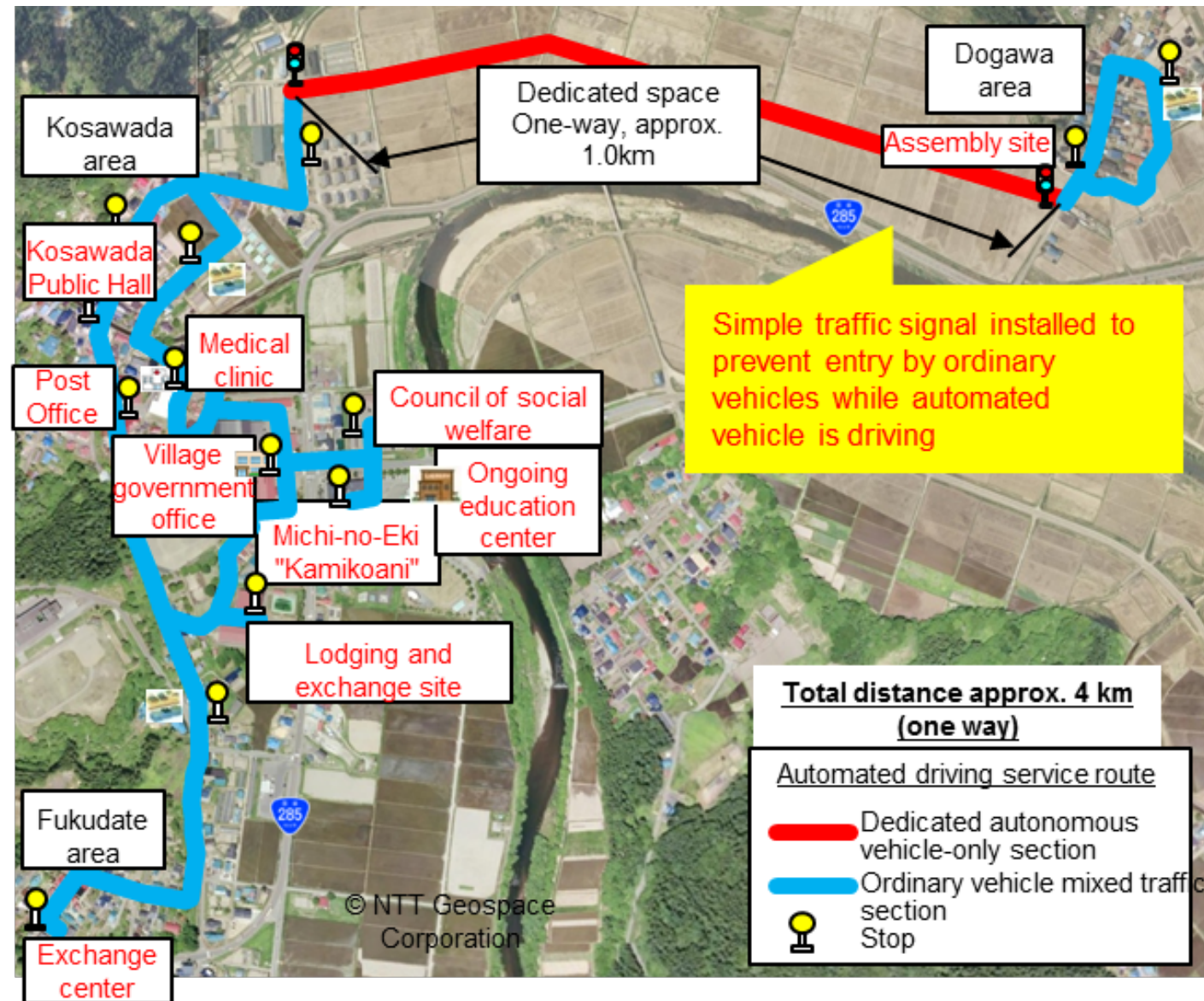
Verification of V2I technologies

Business feasibility

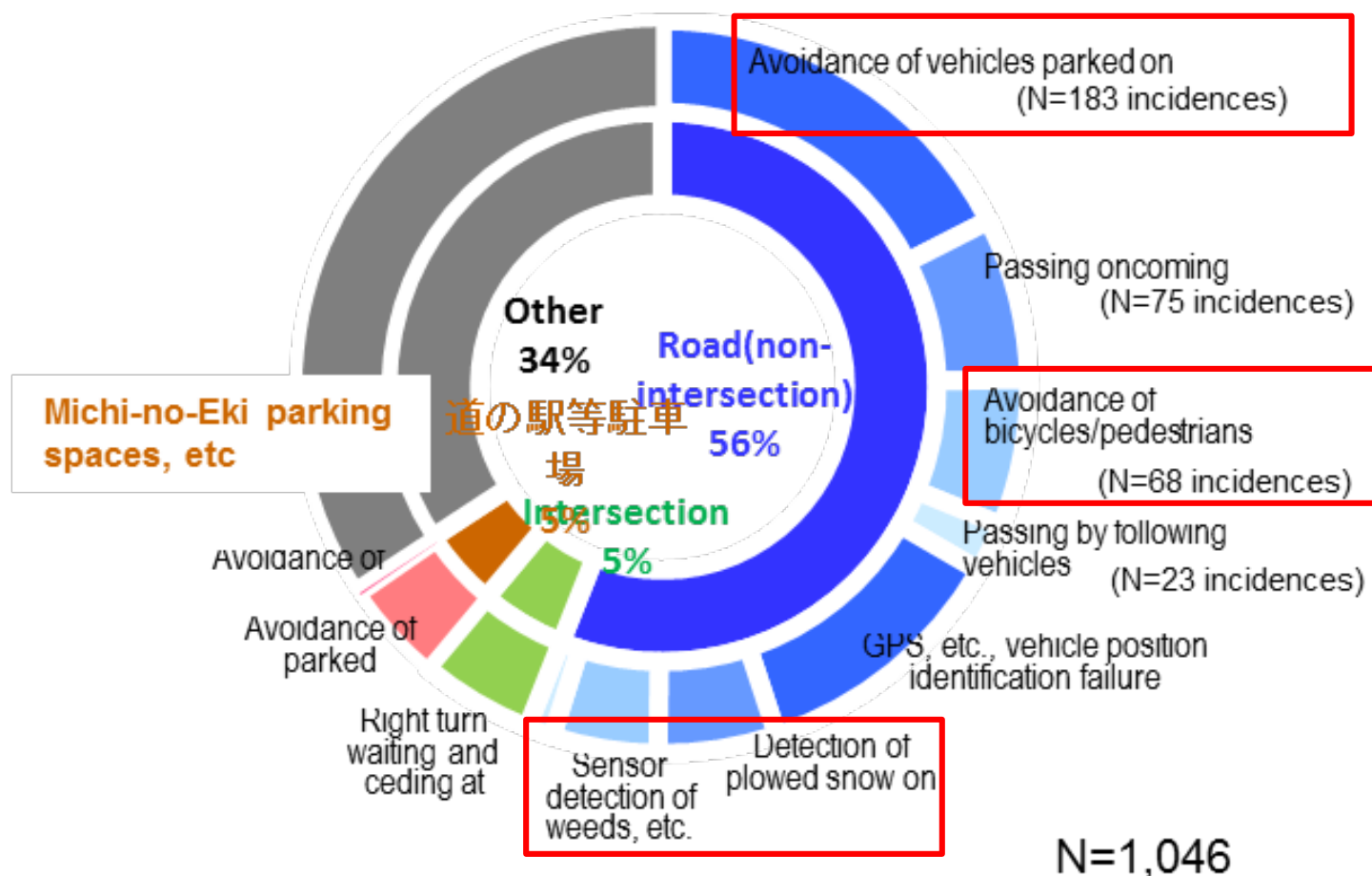


Transport of agricultural products, etc.

Automated service route

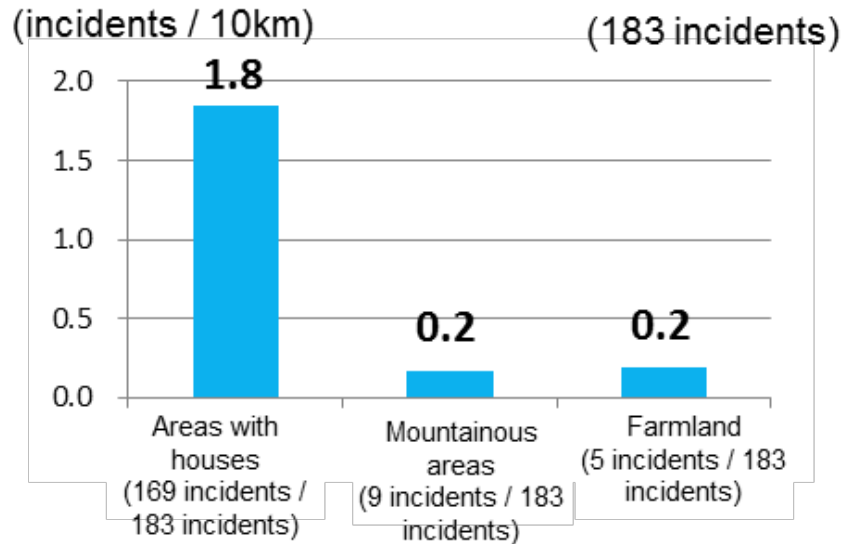


Incidence of manual intervention by cause and road structure (FY 2017 FOT: driving distance 2,200km)



Results in terms of driving spaces

Vehicles parked on road

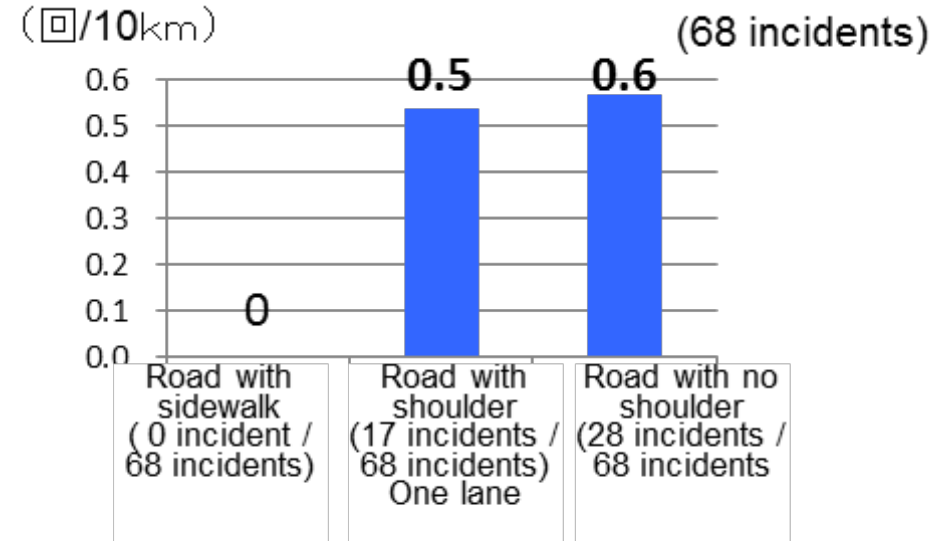


▲ Avoidance of vehicles parked on road

▼ Manual intervention due to vehicles parked on road



Pedestrians / bicycles



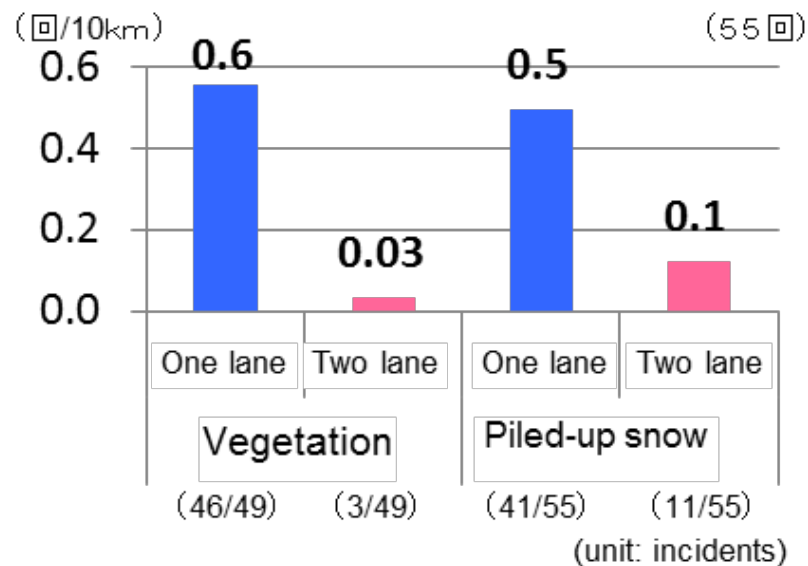
▲ Incidence of pedestrian / bicycle avoidance by cause

▼ Manual intervention to avoid pedestrians on road



Vegetation along road / snow piled on road

▼ Number of sensor detections and avoidances due to vegetation and piled-up snow



▼ Vegetation detected as obstacle, causing vehicle to stop



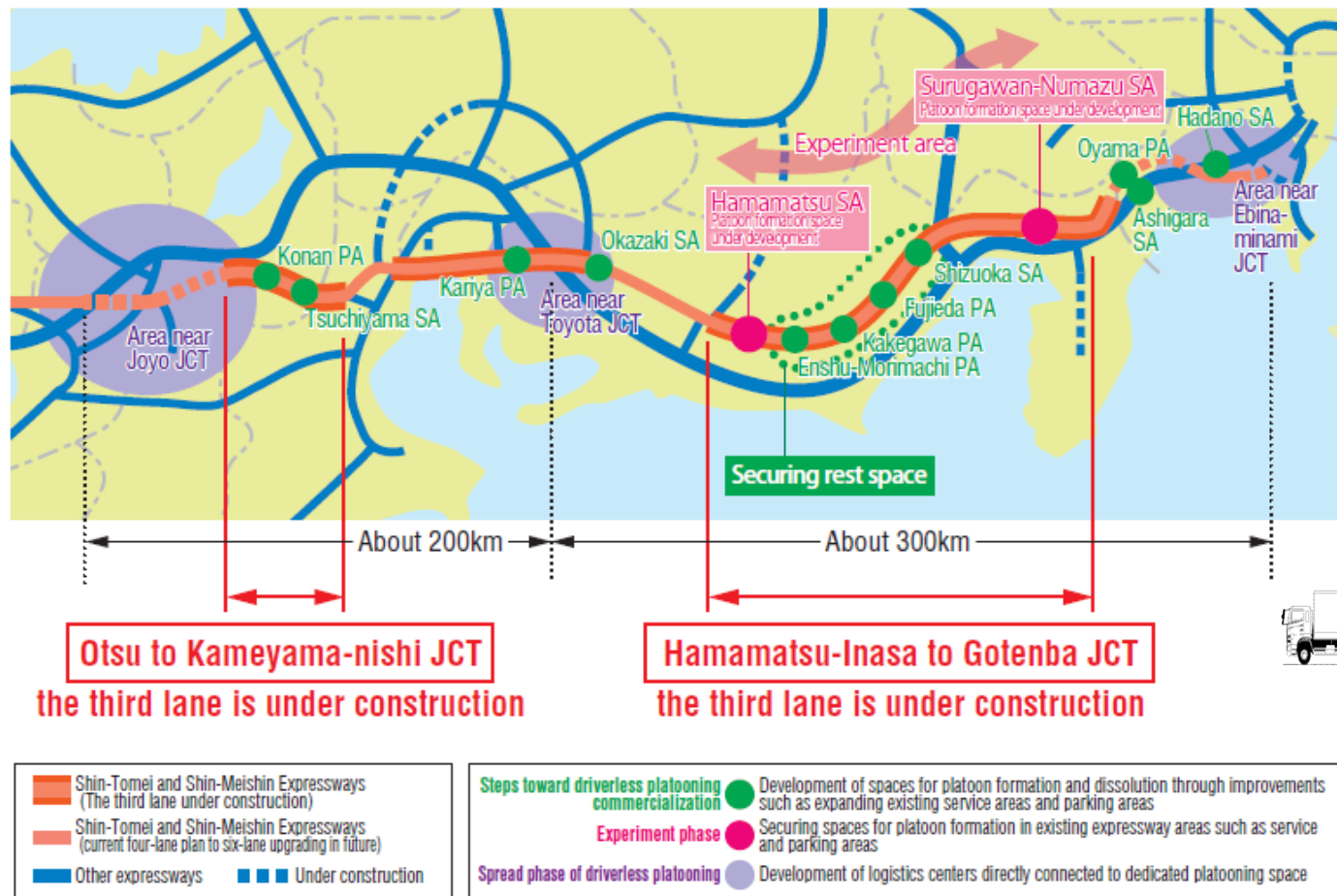
▼ Manual intervention due to narrowing of road caused by piled-up snow



Results in FOTs in Truck platooning

As one solution to **the truck driver shortage**, there are high hopes for the achievement of truck platooning in which only the lead vehicle is manned and the following vehicles are unmanned.

FOTs have been conducted primarily on the Shin-Tomei Expressway.



Results in FOTs in Truck platooning

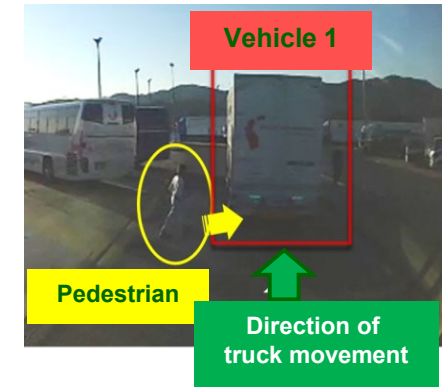
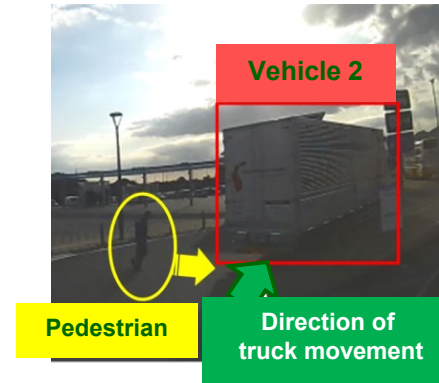
A number of points requiring solutions were listed up in the FOT conducted in the previous fiscal year.

Excerpted from
Ministry of Economy, Trade and Industry
reference

Large vehicle merging interference



Pedestrian congestion in service areas / parking areas



Reduced GPS localization accuracy

Truck No.2 & 3	Average (m)	Maximum (m)	σ (m)
Main roadway	0.17	0.53	0.08
Main roadway, strong winds	0.08	0.31	0.07
Lane change	0.20	0.44	0.06
Left/right turn	0.05	0.37	0.07



Reduced position accuracy under nets

Wire mesh dome

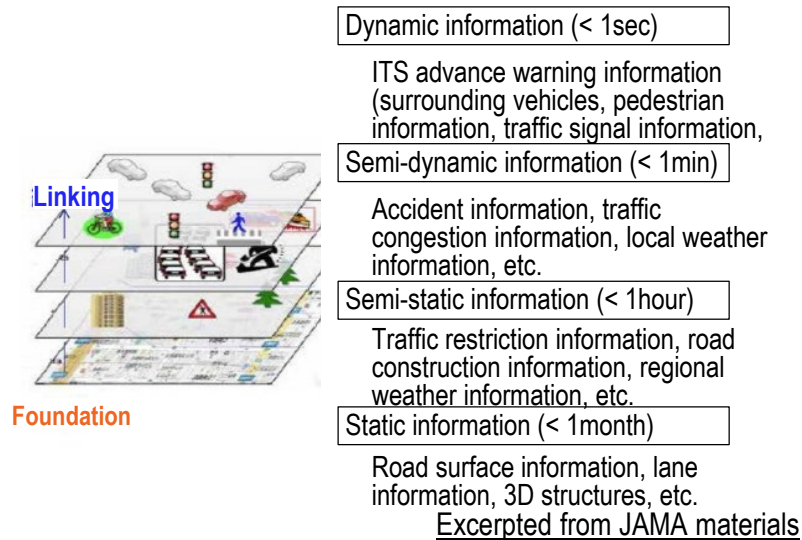
Delays in communication between vehicles

	Average delay (msec)	Maximum (msec)
Optical transmission	14	168
760MHz	268	688
LTE	141	5590

Switching between base stations for communications resulted in large delays.

*In FOTs using 5G on public roads, the transmission delay when transmitting via base stations was roughly 1/10 that of transmission using LTE.

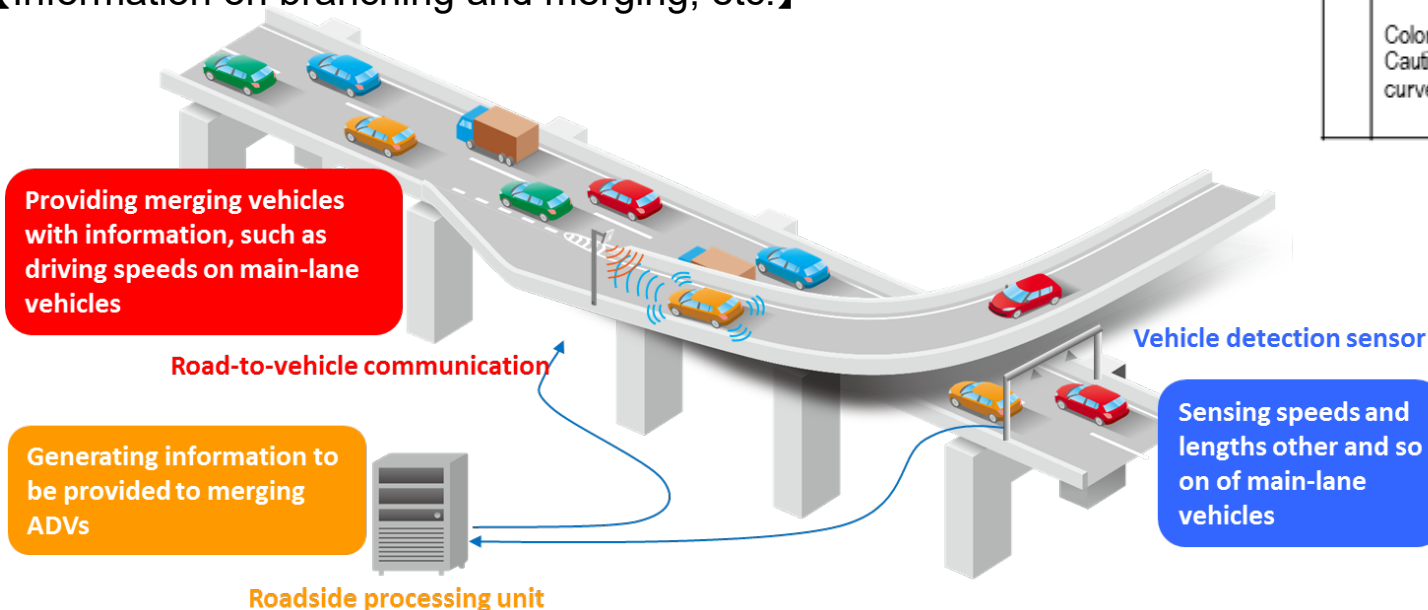
【Preparing HD maps and maintaining map accuracy】



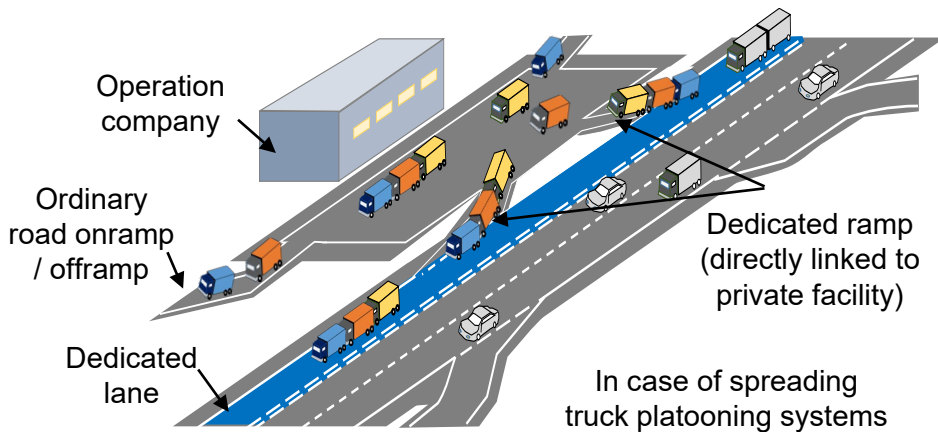
【Ensuring the detectability of lane markings】

No	Road indication (non-statutory indications, etc.)
1	Optical dots: speed control
2	Triple line: speed control/caution
3	Deceleration mark indications in lane
4	Colored pavement: Cautions regarding sharp curves, etc.

【Information on branching and merging, etc.】



- Information on main roadway conditions is provided to merging vehicles.
- Merging vehicle speed and timing are controlled automatically to enable the vehicle to merge safely and smoothly.



Independent dedicated space

- Separate facility structure to prevent entry to dedicated space from other lanes
- Dedicated ramp structure linked directly to logistics center

Road structures to prevent drop in GPS positioning accuracy, etc.

- Structure with magnetic markers and other facilities provided at tunnels, bridges and other locations where GPS positioning accuracy drops
- Structures and specifications for facilities to provide location data from the infrastructure

Space for platoon coupling / decoupling

- Specifications for scale and placement of facilities needed to prevent congestion and ensure safety

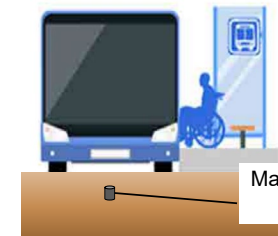
Road facilities needed for self-position correcting during automated driving and when stopping or parking

- Structure of electromagnetic guide lines, magnetic markers and other facilities to support AVs



Electromagnetic guide line

Support for road-vehicle cooperation type automated driving by means of electromagnetic guide lines



Magnetic marker

Infrastructure side support for precise vehicle stop control at bus stops, etc.

Markings in driving spaces

- Standardized markings in driving spaces for self-driving vehicles



Markings on pavement to indicate driving space for self-driving vehicles

Dedicated spaces

- Separate facility, etc. structure to prevent entry to dedicated spaces from other lanes, based on the needs of the local community



Facility for separation from other roads to prevent merging, etc. from ordinary vehicle lanes (Hitachi City test)

FOTs have focused on the use of AVs in hilly and mountainous areas, in order to address social issues caused by the aging of local society;

The results of FOTs can be summarized as follows;

(1) Passenger acceptance

Experience of AVs travel increases their acceptability of local residents.

(2) Labor cost saving

Labor costs can be reduced by substituting semi-paid volunteers for professional drivers without a loss of efficiency.

(3) Integration into regular bus route service

Even low-speed AVs can efficiently connect local homes with regular bus stops.

(4) Business feasibility

Welfare authorities can provide adequate AV service subsidies without burdening local authority transportation budget.