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Low Speed Automated Driving (LSAD) Services in Rural Depopulated Areas

SHINJI ITSUBO, Ph.D

Senior Researcher, ITS Division, Road Traffic Department

National Institute for Land and Infrastructure Management (NILIM),

Ministry of Land, Infrastructure, Transport and Tourism (MLIT),

JAPAN

(E-mail: itsubo-s257 @ mlit.go.jp)

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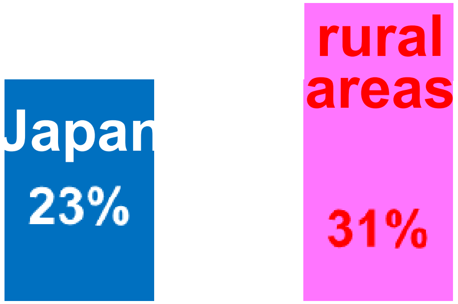
1.1 Issues in rural depopulated areas

- It gets difficult to maintain daily-life services.

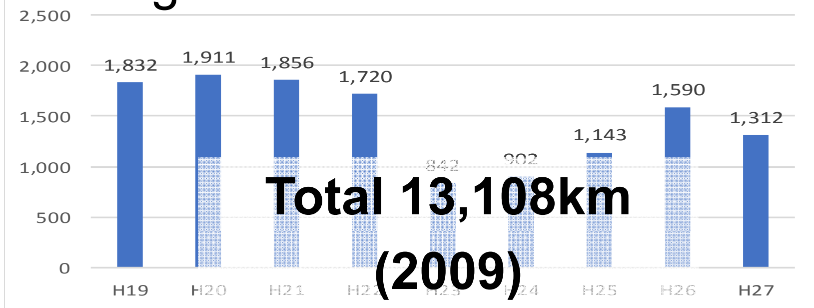
Rapidly aging population

Ratio of the population over 65 years old to the total population (2010)



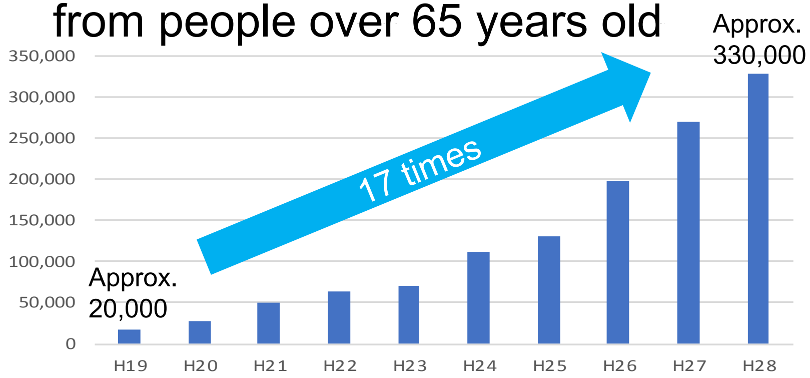
Abolishment of public transport to go shopping and/or to clinics

Length of bus routes abolished



Rapid increase of elderly people who cannot drive

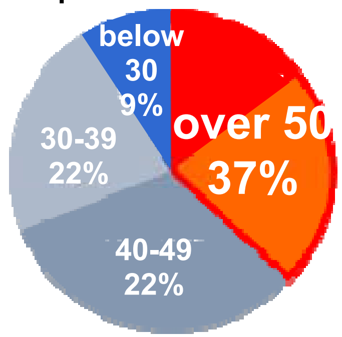
Number of returned driving licenses from people over 65 years old



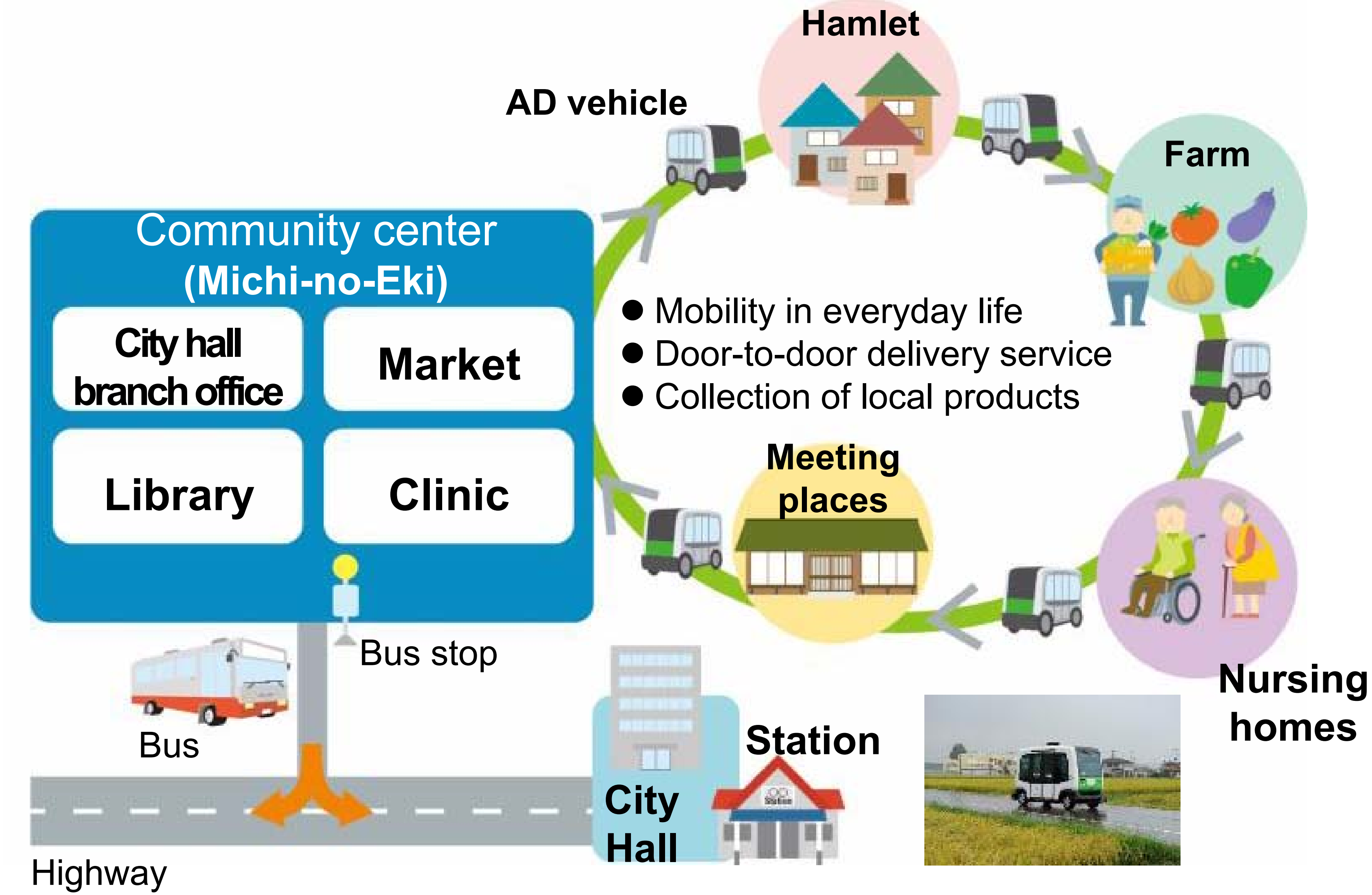
Shortage of truck drivers who deliver goods

Age group of truck drivers

About 40% of truck drivers are over 50 years old.



- Expect to ensure both people and goods transport, and further local revitalization.
- A series of pilot project with AD vehicles were started in 2017.



2.1. Schedule of the FOTs

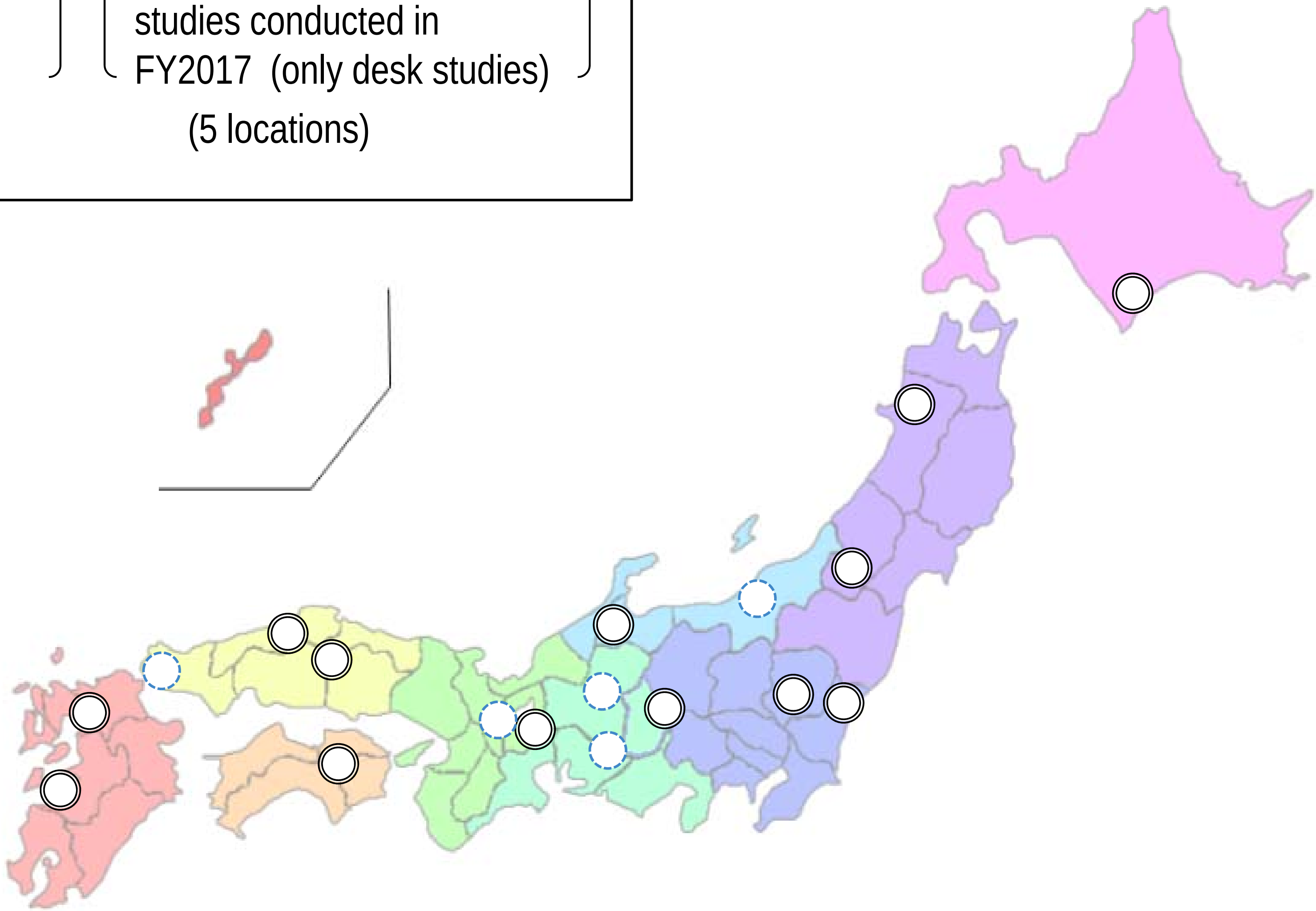
	Field operational tests	Business model
FY2017	Start of tests at 13 locations in Japan **(Designated by MLIT (5 locations), Designated by public invitation (8 locations)/Feasibility study(5 locations))**	**<u>Business model review conference</u>**
FY2018	**Long-term FOTs** ● Building a business model ● Aiming for early deployment ● Conducting FOTs for 1 or 2 months based on the concreteness and the feasibility of business model and local acceptance Short-term FOTs (if necessary) and feasibility studies	Interim summary (Around summer time) Agenda ・Utilization of road space ・Technology based on the demands in rural mountainous areas ・Business model etc

Aiming for deployment of AD service from Michi-no-Eki etc., no later than 2020

2.2. Locations of FOTs (FY2017)

◎ : Locations of FOTs
(Locations of short-duration FOTs conducted in FY2017)
(13 locations)

○: Locations of FSs
(Locations of feasibility studies conducted in FY2017 (only desk studies))
(5 locations)



3. Test-vehicles

Bus type

1) DeNA Co., Ltd.

Autonomous technology
- Identify own position by GPS and IMU.
- Drive according to a predetermined route.
- Acquire point-group data.

Capacity: **6 people (seated)** (Total 10 people seated and standing)

Speed: **Approx. 10km/h** (Max: 40km/h)

2) Advanced Smart Mobility Co., Ltd.

V2I technology
- Identify own position and drive a predetermined route using GPS, magnetic markers and gyro sensors.

Capacity: **20 people**

Speed: **Approx. 35km/h** Max. 40km/h

Passenger-car type

3) Yamaha Motor Co., Ltd.

V2I technology
- Drive a predetermined route by following embedded magnetic-induction lines.

Capacity: **Approx. 4–6 people**

Speed: **Automated: Approx. 12km/h** Manual: <20km/h

4) Aisan Technology Co., Ltd.

Autonomous technology
- Drive a predetermined route using a high-precision 3D map.
- Detect surrounding conditions by LIDAR.

Capacity: **4 people**

Speed: **Approx. 40km/h** Max. 50km/h

GPS: Global Positioning System
IMU: Inertial Measurement Unit
LIDAR: Light/Laser Imaging Detection and Ranging

4. Technical Evaluation viewpoint（FY2017）

1) Roads and traffic

e.g., Typical road in rural area

1) Road structure (Straightness, grade, etc.)
2) Road management (demarcation lines, planted trees, etc.)
3) Support for mixed traffic
4) Space required

2) Environmental conditions

e.g., Snowy roads

1) Weather conditions (rain, snow, etc.)
2) Communication conditions (GPS reception)

3) Costs

e.g., Installation magnetic induction lines

1) Costs for vehicles
2) Costs for others

4) Public acceptance

1) Comfort(speed, psychological impact, etc.)
2) Convenience (routes, frequency of service, etc.)

5) Beneficial effects on regions

e.g., Combined transport of passengers and cargo

1) Opportunity for elderly to go out
2) Collection and shipping of agricultural produce, etc.

5. Technical Validation on FOTs (FY2017)

Description
◎Case without problem / ○Case that vehicle stopped appropriately (to be taken care for smooth running) / ●Case with problem that should be resolved

Item		Key Case Identified	Next Step (draft)
Road Geometry	Horizontal alignment	◎AVs drove smoothly regardless of road alignment. (even on winding roads in Mountainous area.)	
	Slope	◎AVs drove smoothly regardless of road slope. (even on sharp slope section in Mountainous area.) ○Sharp slope was sometimes detected as an obstacle.	
	Road width	○On sections with narrow shoulder without sidewalk, AVs sometimes detected pedestrian/ cyclist and stopped/switched to manual operation for them.	• Indicate path of AVs clearly. • Build understanding and cooperation of residents
	Intersection	○At unsignalized intersections, AVs sometimes stopped/switched to manual operation to give way to other vehicles due to unclear priority, narrow road width and lack of communication with other vehicles. ○Where visibility is limited, manual operation was sometimes set in advance.	• Put simple signals at intersections.
Road Maintenance	Planting	○Depending on setting of running position, AVs detected planting/weed on roadside (or those expanding from roadside to road section), and stopped/switched to manual operation for them.	• Set AVs with appropriate (lateral) running position. • Maintain planting appropriately (sometimes need cooperation of private land).
	Snowfall	◎AVs drove smoothly in fallen/compacted snow condition (around 10cm depth). ●Snow piling on roadside was sometimes an obstacle for AVs.	• Snow plough for path of AVs. • Set AVs with running position for snow condition.

5. Technical Validation on FOTs (FY2017)

MLIT

Description

◎Case without problem / ○Case that vehicle stopped appropriately (to be taken care for smooth running) / ●Case with problem that should be resolved

Item		Key Case Identified	Next Step (draft)
Mixed traffic	Oncoming vehicle	◎AVs passed smoothly with oncoming vehicles on 2-lane sections. ○On narrow sections (e.g. 1-lane sections), AVs detected oncoming vehicles and stopped/ switched to manual operation for them.	• Install turnouts. • Build understanding and cooperation of residents (consideration on defining priority or network rearrangement with one-way roads).
	Following vehicle	◎When speed of AVs were mostly same with normal vehicles, they drove smoothly. ○Since some types of AVs drove at lower speed than normal vehicles, following (un-automated) vehicles sometimes overtook AVs or made up a queue behind them.	• Install dedicated (or prioritized) lane. • Install turnouts.
	On-street parked vehicle	●When AVs detected on-street parking vehicles, it stopped/switched to manual operation for them.	• Indicate path of AVs clearly. • Build understanding and cooperation of residents (control of on-street parking)
Roadside rest area (Michi-no-eki)	Space	○AVs sometimes detected pedestrians, bicycles and motorcycles and stopped/switched to manual operation for them. ○When snowing, AVs sometimes detected vehicles which parked off the parking slot onto driving lane because their boundaries cannot be seen due to snow, and stopped/switched to manual operation for them.	• Clearly indicate lanes where AVs drive. • Design parking space for bicycles and motorcycles. • Snow plough for path of AVs.

6.1. Technical validation at the FOT (FY2017)

- Following vehicle overtook the AD vehicle on “No overtaking” section.
- Appropriate passing place should be provided.

Speed difference btw. AD vehicles and normal vehicles

6.2. Technical validation at the FOT(FY2017)

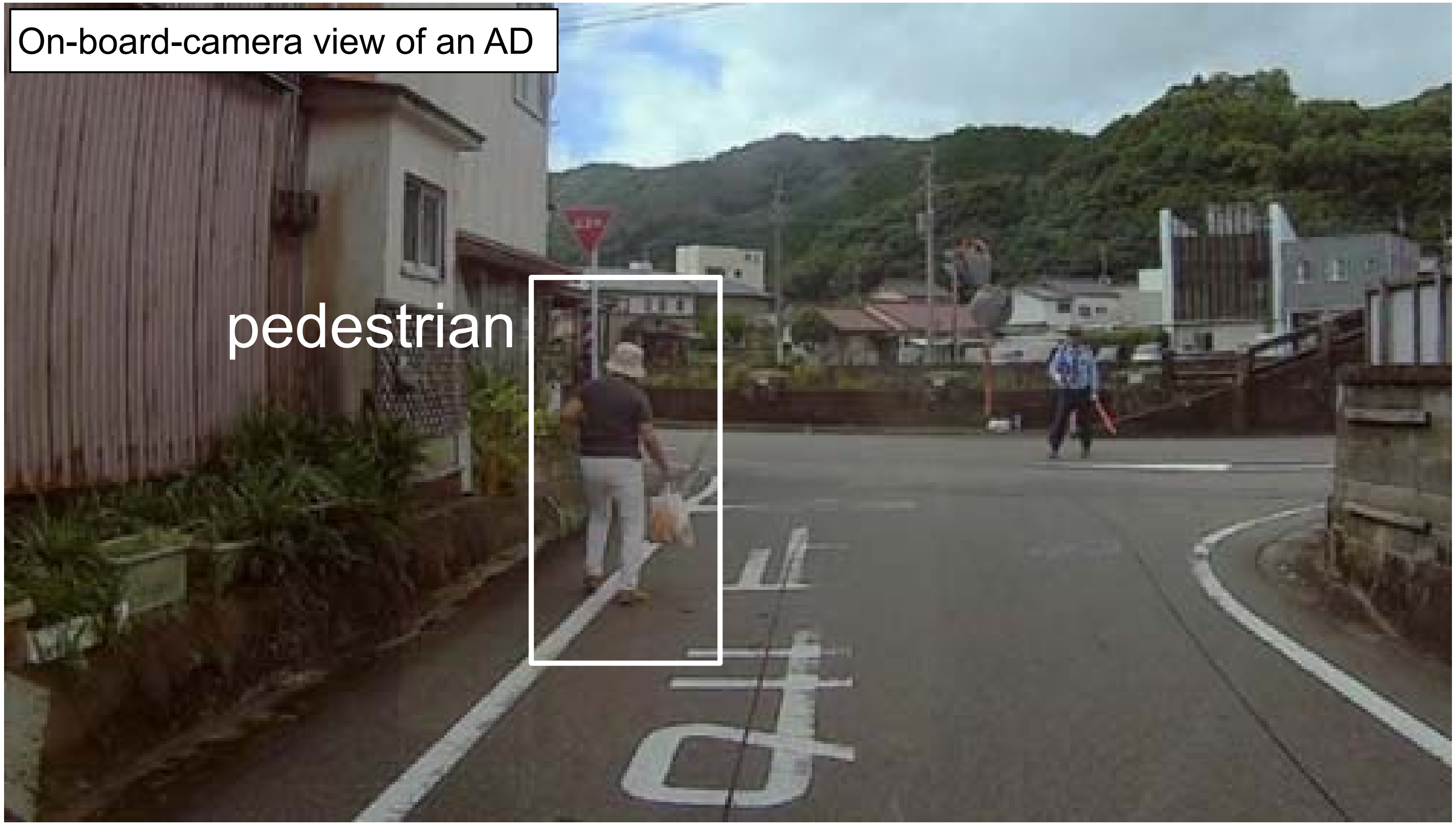
- Roadside bushes were detected as obstacles on the path of AVs.
- Appropriate maintenance level should be considered.

Poor maintenance of rural road

6.3. Technical validation at the FOT(FY2017)

- On the sections with narrow shoulder and no sidewalk, AVs sometimes detected pedestrian/cyclist and stopped / switched to manual driving.
- Path of AVs should be clearly indicated.

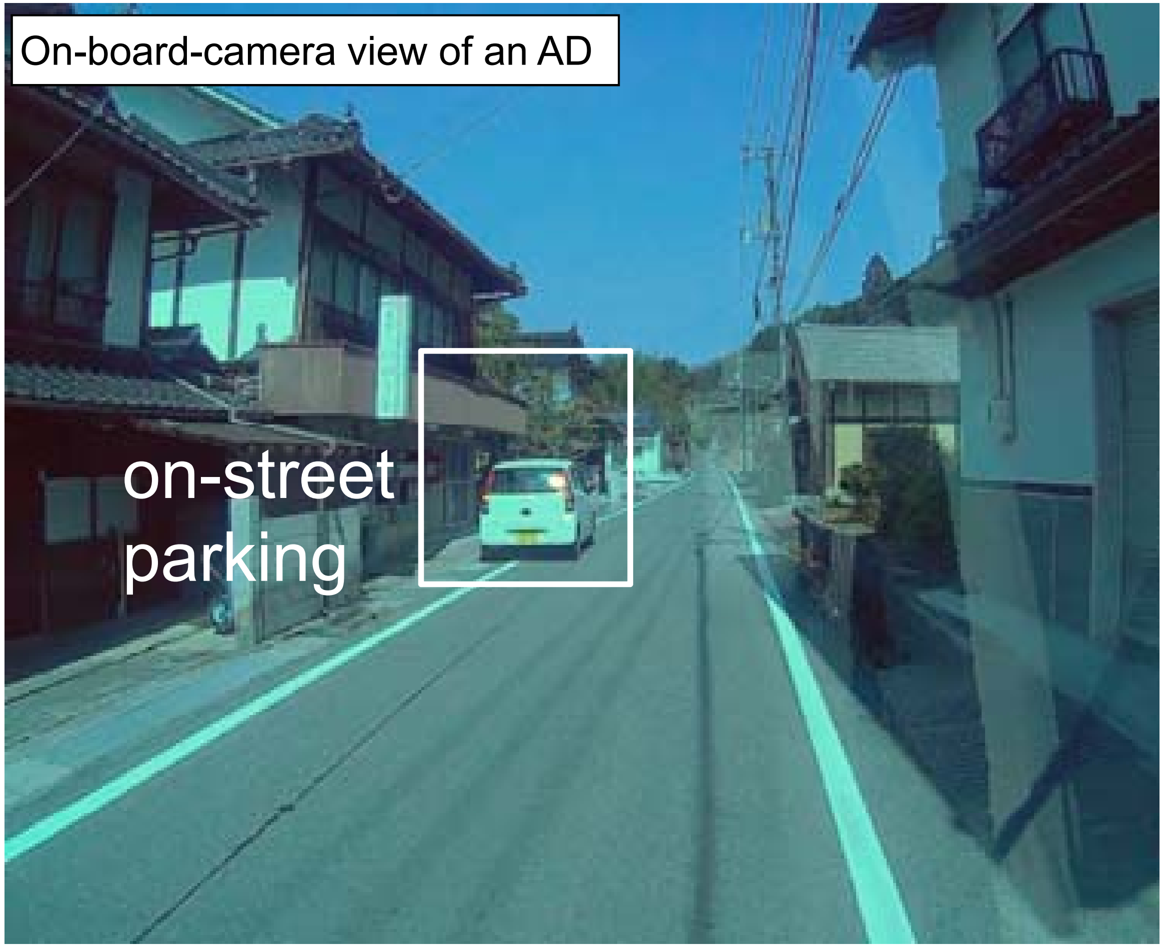
Pedestrian / bicycle



6.4. Technical validation at the FOT(FY2017)

- AVs stopped / switched to manual driving when detecting on-street parked vehicles.
- Path of AVs should be clearly indicated.

On-street parking vehicle



6.5. Technical validation at the FOT

Environmental condition is severe in rural area.

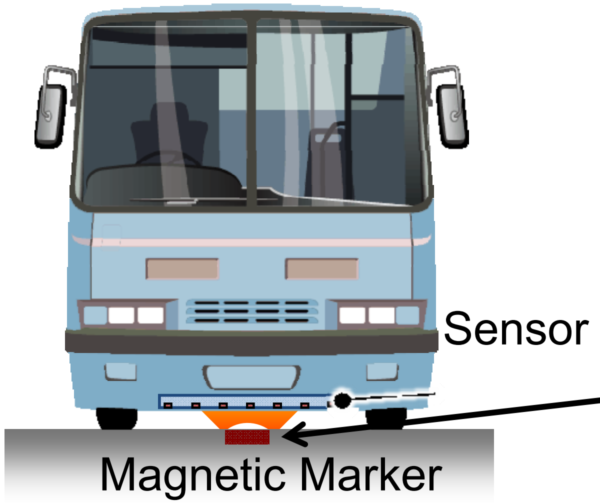
e.g. AD vehicle cannot catch GPS signal due to forest.

Performance of Lidar sensors decrease in snowy condition.

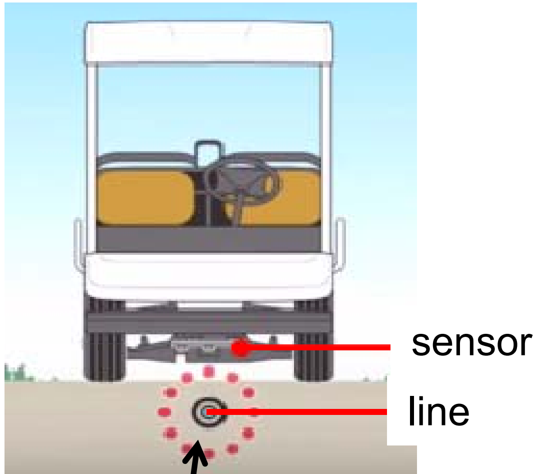
Some of the AD vehicle providers use low-tech but robust technology against severe weather, so that vehicles can identify their own location accurately.

Magnetic markers (Advanced Smart Mobility Co., Ltd)

Magnetic-induction lines (Yamaha Motor Co., Ltd.)

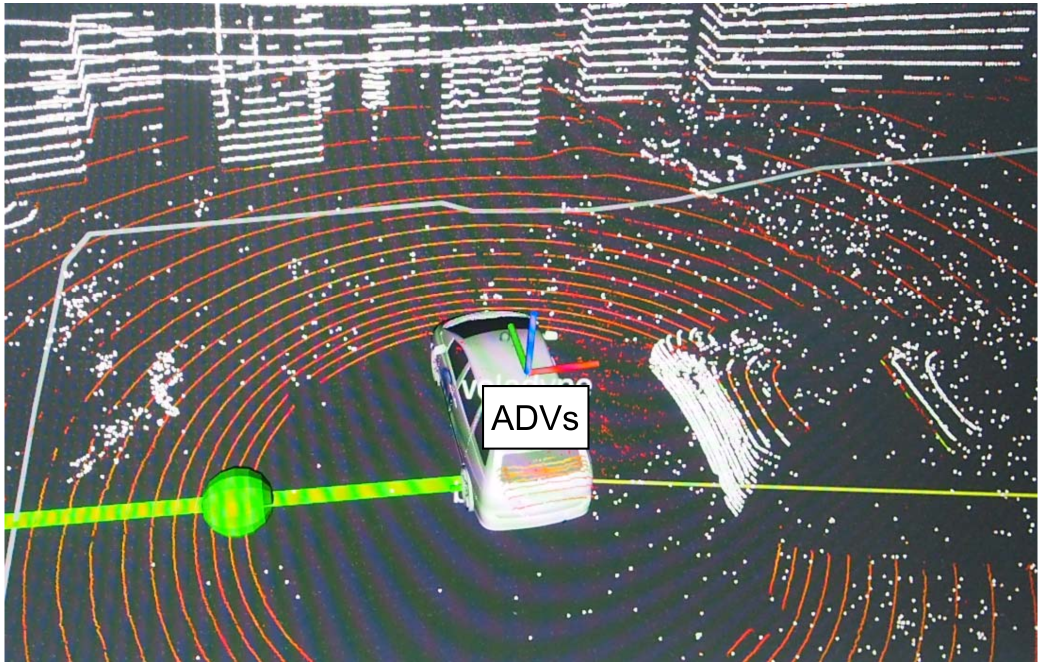


Magnetic marker



Some of the issues to be solved

Performance decrease of on-board sensors in severe weather condition

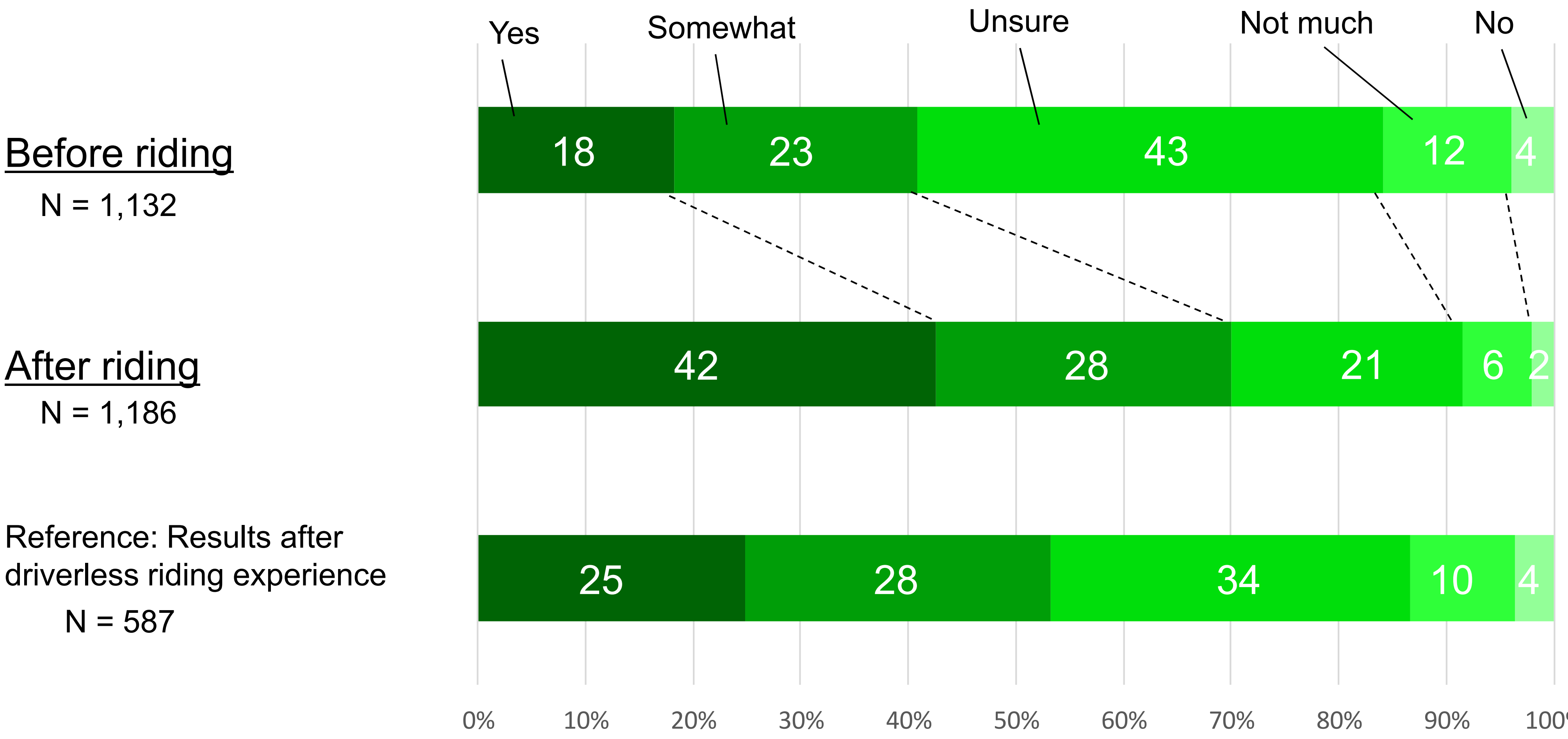


Snow particles are detected and prevented ADVs from recognizing surrounding environment

Appropriate combination of on-board sensor should be considered.

- More public participants put their trust in AD technology after they tried it.
- More of them put their trust in AD technology even though they experienced only driverless AD.

Q3. Do you think AD technology can be trusted?



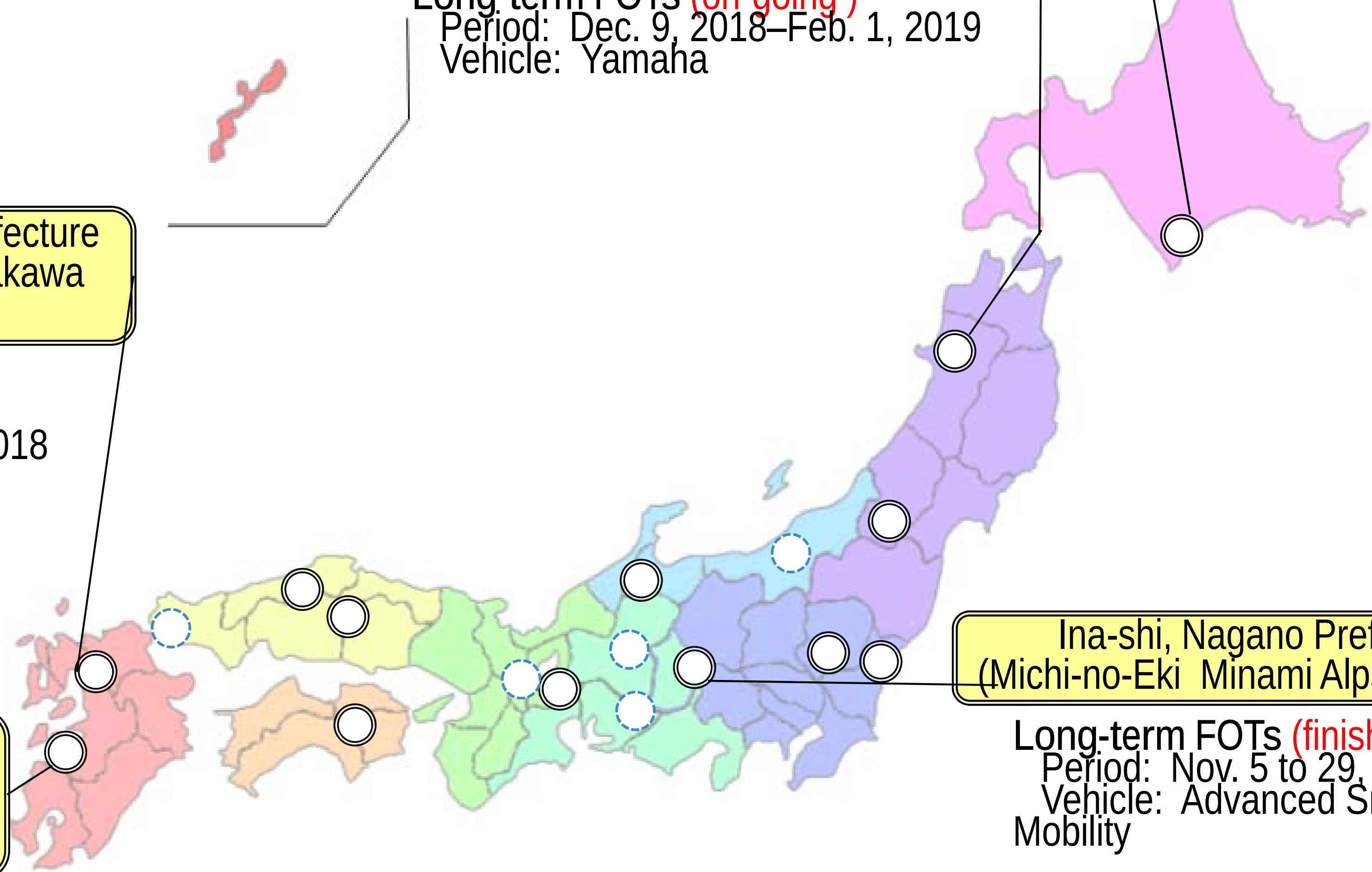
8.1 Locations of for long-term FOTs

Taiki-cho, Hiroo-gun, Hokkaido (Michi-no-Eki Cosmall Taiki)

A Regional Test Council was convened in preparation for long-term FOTs.

Kamikoani-mura, Kita-akita-gun, Akita Prefecture (Michi-no-Eki Kamikoani)

Long-term FOTs (on-going)
Period: Dec. 9, 2018–Feb. 1, 2019
Vehicle: Yamaha



Miyama-shi, Fukuoka Prefecture (Miyama City Hall, Yamakawa Branch)

Long-term FOTs (finish)
Period: Nov. 2–Dec. 21, 2018
Vehicle: Yamaha

Ina-shi, Nagano Prefecture (Michi-no-Eki Minami Alps Murahase)

Long-term FOTs (finish)
Period: Nov. 5 to 29, 2018
Vehicle: Advanced Smart Mobility

Ashikita-machi, Ashikita-gun, Kumamoto Prefecture (Michi-no-Eki Ashikita Dekopon)

A Regional Test Council was convened in preparation for long-term FOTs.

8.2. Key Features of Long-term FOTs (FY2018)

Technical aspects

1. Establishing standards for road areas for ADVs

・Methods of securing dedicated and/or priority space fit to each area

2. Operation management systems according to regional characteristics

・Establishment of an operation management center for ADVs

・Methods for monitoring driving status and conditions of vehicles inside

Business model

3. Implementation of FOTs in preparation for future commercial operation

・Automated-driving service providers and other operating bodies are considered according to regional conditions.

・Low-cost operational methods, such as the use of participation by local volunteers.

4. Linkage with various regional activities to support AD services

・Social services: Local-government support through nursing-care services at Michi-no-Eki, etc.

・Logistics: Mixed transport of passengers and cargo of agricultural products and sundries

5. Fare collection

・Examination of economic feasibility and sustainability through daily use

8.3. Verification of Operation Management Systems (FY2018)

Operation Management Center

- monitor operations by viewing images of vehicle interiors and checking vehicle position data.

Operation management center established at Michi-no-Eki

Monitoring of vehicle interior

Confirmation of vehicle position

Reservation and ticket system

- IC cards are issued .
- Most reservations are made when customers register in person or over the telephone.

IC card

Issue of IC cards

Reservation system using smartphone app

Verification of the system Practicality

Assessment of the convenience of the system

Securing priority driving spaces

- Local people were asked to cooperate.
- Road surface markings and revolving lights were installed to notify of autonomous-bus routes.
- Provisional signals were installed to make dedicated areas.

Roadside sign with revolving light

Printed notice for local people

Provisional signals for dedicated area for ADVs

Autonomous vehicle in operation

Road surface marking

Verification of the effectiveness of each methods

A table of Contents

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