SIP Automated Driving in Japan

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SIP : Cross-Ministerial Strategic Innovation Promotion Program

SIP

Cabinet Office

1. SIP Overview

SIP : Cross-Ministerial Strategic Innovation Promotion Program

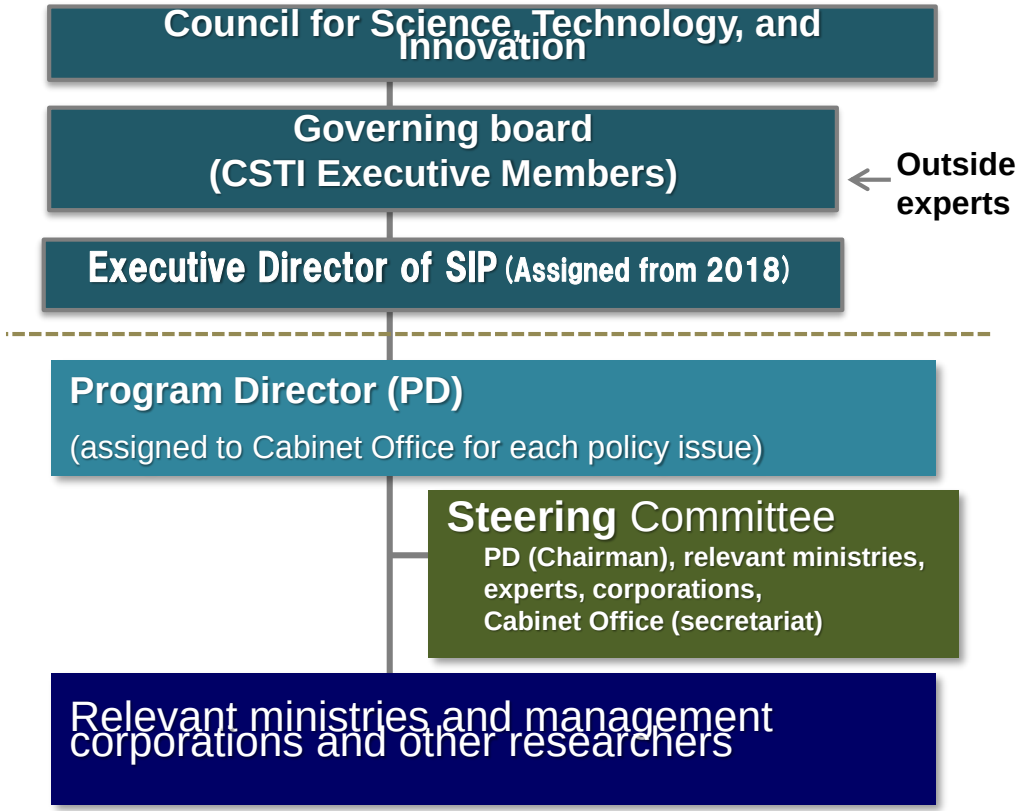
Outline of SIP

- **Intensive R&D program**
  - ✓ promote 5-years R&D (FY2014 - FY2018)
  - ✓ from fundamental research to practical and commercialization
- **Promote cross-sector collaboration**
  - ✓ enhancing cross-ministerial cooperation
  - ✓ promote industry-academia-government collaboration
- **Leadership and total Budget**
  - ✓ CSTI appointed Program Directors and allocates the budget for each research theme.*

* ¥50bil in total per year
(65% for SIP 11 themes, 35% for medical R&D)

SIP

Cross-Ministerial Strategic Innovation Promotion Program



Promotion Framework of Japanese Government

Cabinet Secretariat
(IT Strategic Headquarters)

Cabinet Office
(Council for Science, Technology and Innovation)

Program Director
Mr. Seigo KUZUMAKI
(Toyota Motor Company)

NPA
(National Police Agency)

Road traffic safety

MIC
(Ministry of Internal Affairs and Communications)

Info-Communication Technology for ITS

METI
(Ministry of Economy, Trade and Industry)

Promotion of the automobile industry

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

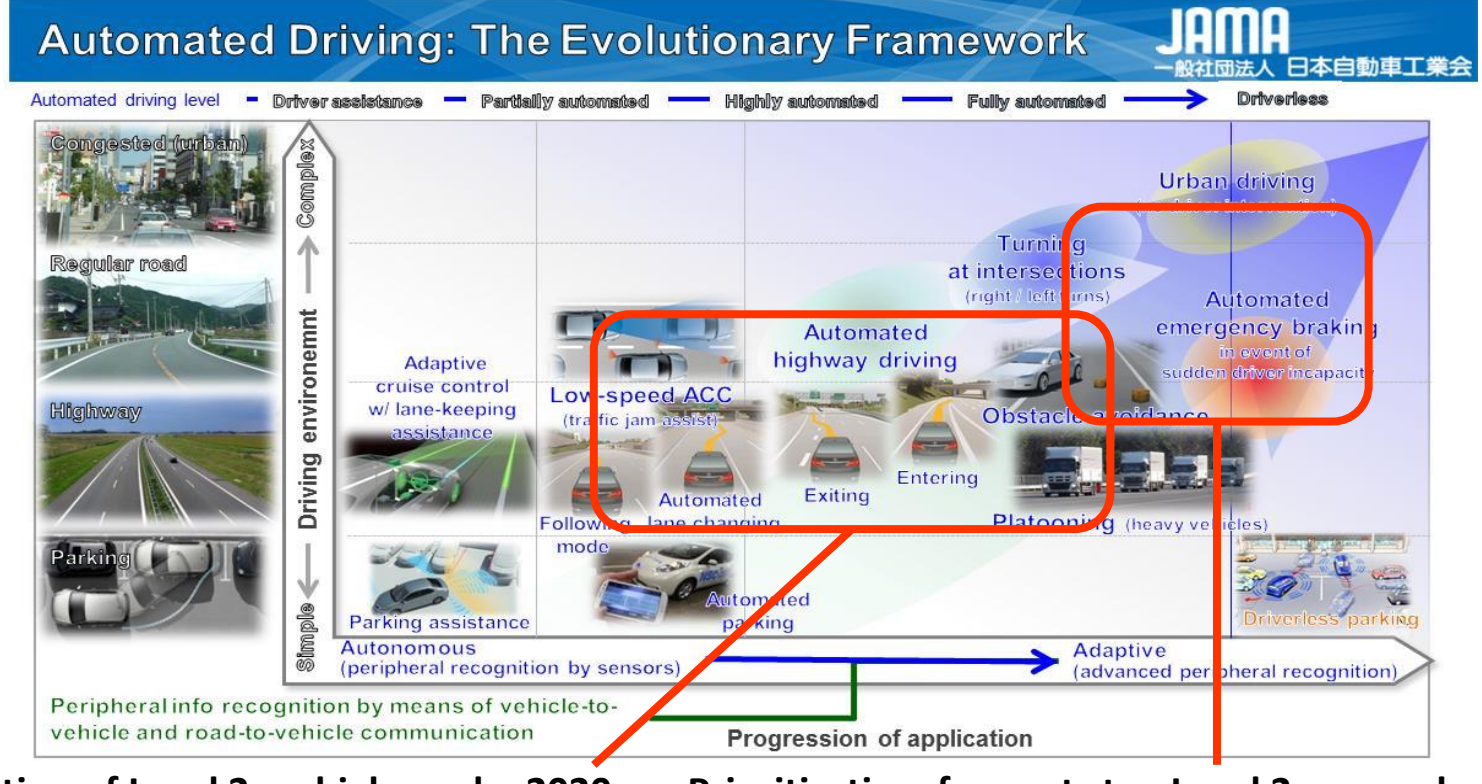
Road Bureau
Deployment of road infrastructure

Road Transport Bureau
Safety standards for automobile

SIP-AD project name is "SIP-adus"
: Automated driving systems for universal service

Goal & Exit Strategy

- Ensuring safety and traffic jam reduction on the road
- Realization and spread of Automated Driving System
- Realization of advanced next generation public bus service for vulnerable people.



Realization of Level 2 on highway by 2020

Prioritization for next step Level 2 on regular road

Automated Driving Car Example

2. SIP Research Items

SIP : Cross-Ministerial Strategic Innovation Promotion Program

Technologies for Automated Driving Systems

Vehicle

Recognition — Sensor, Map, ITS info.

Judgment — Artificial intelligence

Operation — Actuator

HMI

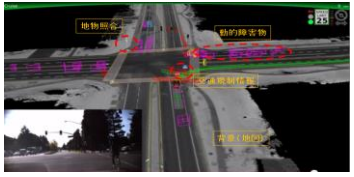
HMI:
Human
Machine
Interface

Cooperation with Human

- A highly self-position estimation
- Neighboring environmental cognition

These are important for Automated Driving System

Dynamic Map



High-definition digital map

ITS Anticipative Information

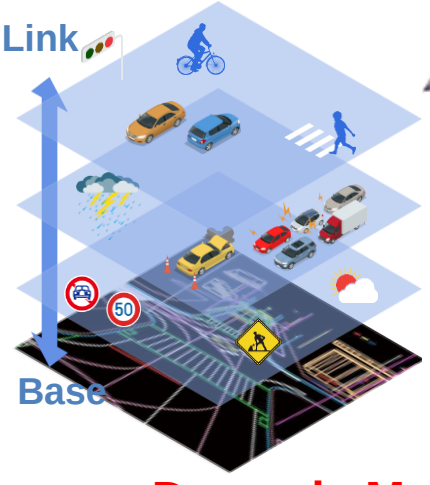
Onboard sensors

In red ：Area of Cooperation
⇒ Main Area of SIP

Basic Tech. Security, Simulation, Database, etc.

SIP focus on the R&D in Cooperative area with Industry, Academia and Government

SIP Research Items



Dynamic Map+ GNSS

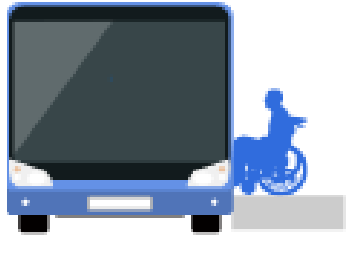
Social Acceptance

Pedestrian Traffic Safety

V2X

Security

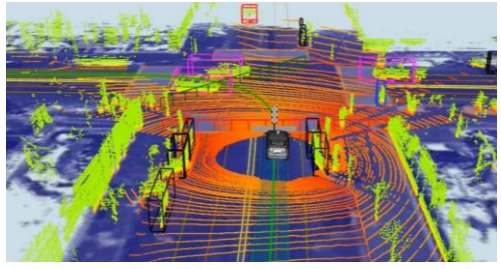
Human Machine Interface



Advanced Rapid Transit

Vehicle Localization Estimation

- Feature detecting by high accuracy three-dimensional measurement



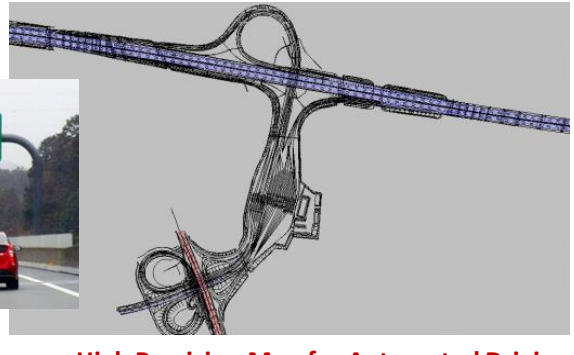
Source : Google HP

- Position reference using feature detecting and three-dimensional high-precision map data

Map Database for Car Navigation

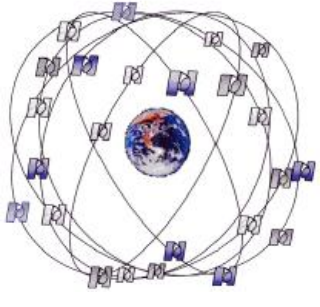
Source : Dynamic Map Platform Co., Ltd

Feature detecting



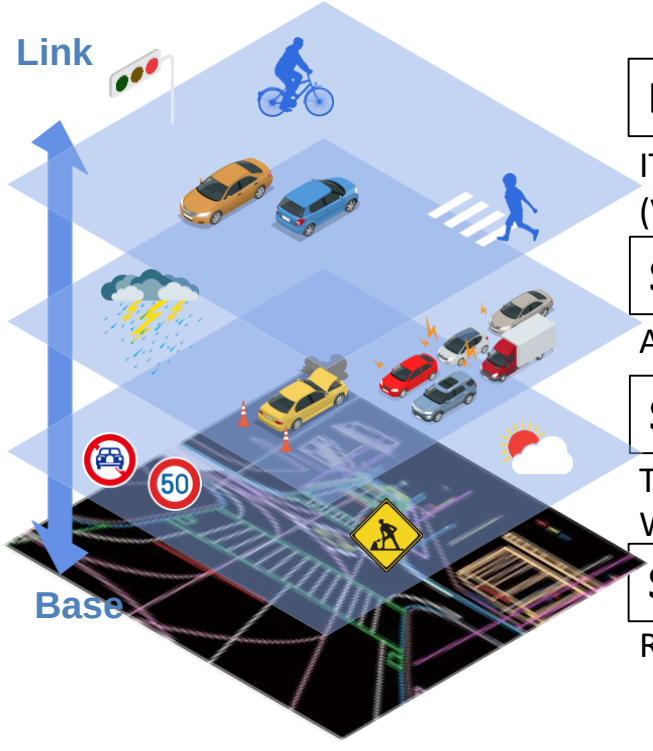
High Precision Map for Automated Driving

- Use GNSS



Dynamic Map

➢ **Use Dynamic Map as an advanced traffic info. database for all vehicles, not only as a precise map for automated driving vehicle.**



Dynamic Info. (Changes in short time.)

ITS anticipative Info.
(V2V, V2P, traffic signal rotation cycle, etc.)

Semi-dynamic Info.(Current phenomenon)

Accident, Congestion, Local weather etc.

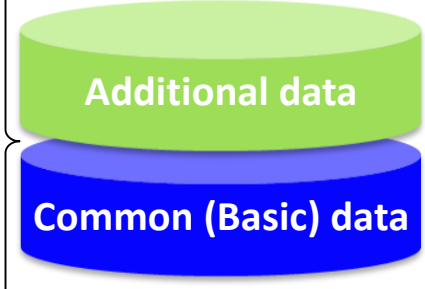
Semi-static info.(Scheduled phenomenon)

Traffic control plan, Road construction plan,
Weather forecast, etc.

Static Information

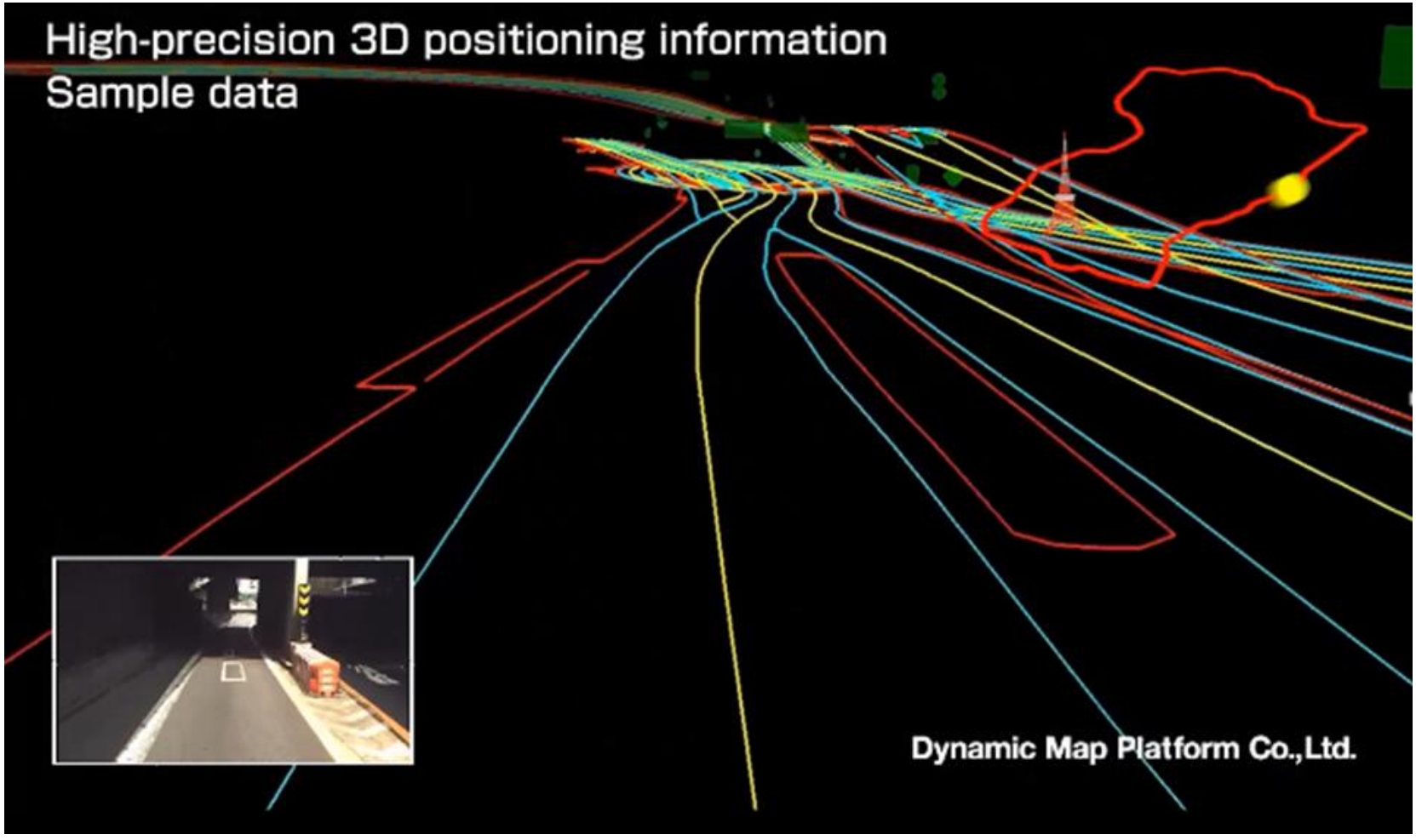
Road shape, Topological data, etc.

Competitive area



Cooperative area

Three-Dimensional High-Precision Map Movie



(Source：Dynamic Map Platform Co. Ltd)

3. Satellite Positioning

GNSS for Automated Driving

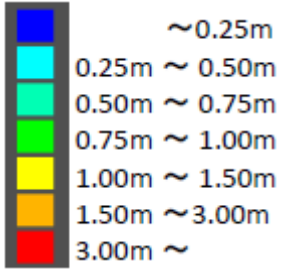
- On the assumption of using on-board sensors and position determination systems on the dynamic map, it is considered to utilize the satellite positioning information to complement them.
  - Multi-GNSS positioning effectiveness on high speed moving vehicles including QZSS.
  - Quantitative estimation of positioning accuracy by high performance reference method.
  - Multi-Pass reduction effectiveness in the city area.

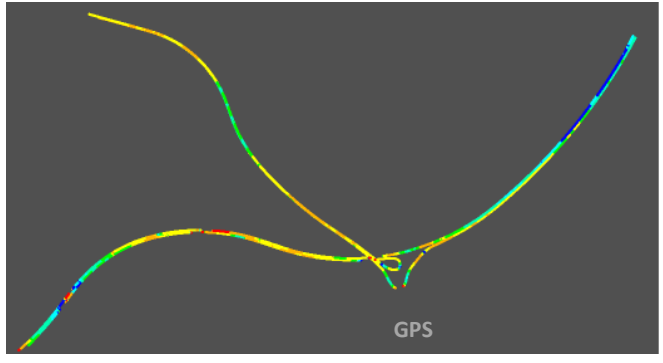
Source: SIP-adus Report “Survey on utilization of satellite positioning information for realization of automated driving system 2015, 2016”

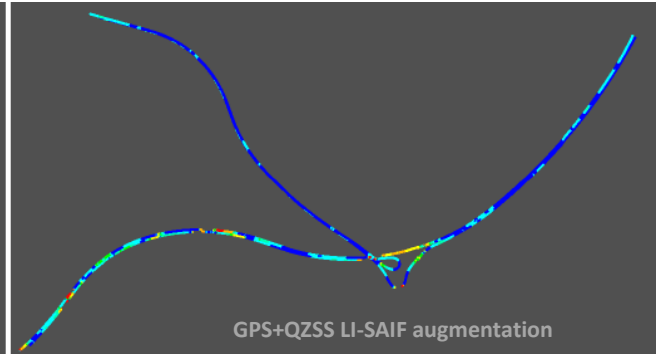
QZSS and GNSS Positioning Accuracy

- By using the augmentation information created by same way as QZSS L1S, the error in the lateral direction became 0.55 m (RMS), and it has become clear that it is effective for improving accuracy of single frequency positioning results even on moving vehicle.

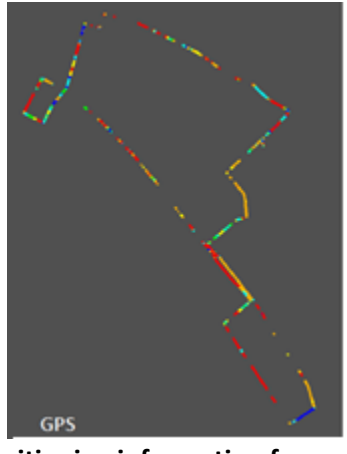
the error in the lateral direction

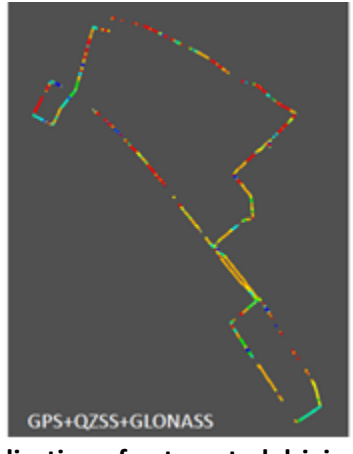


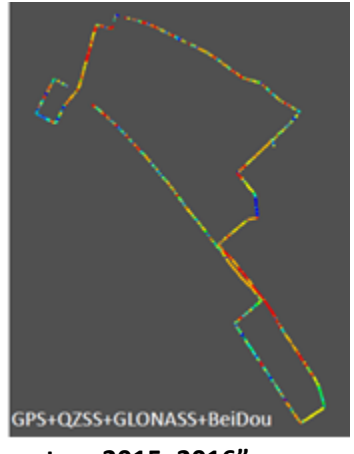




- Multi GNSS is also effective only using satellites which have good broadcast ephemeris. However, it took about over 10 sec to get new position after passing the underpass, in this research



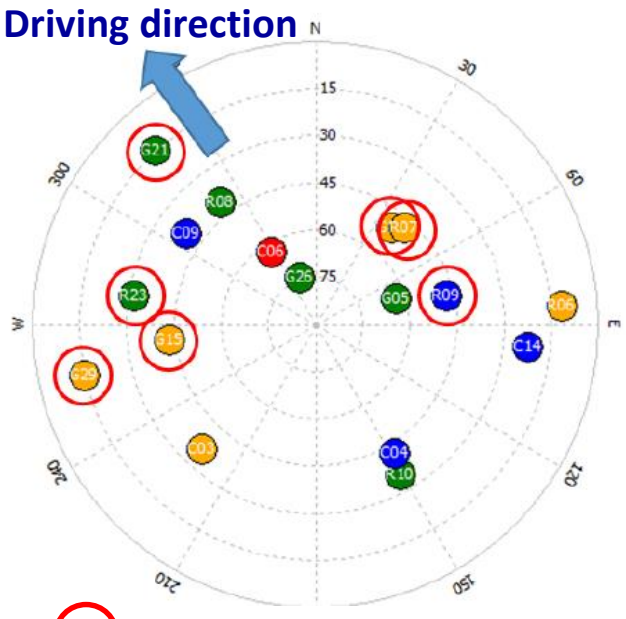


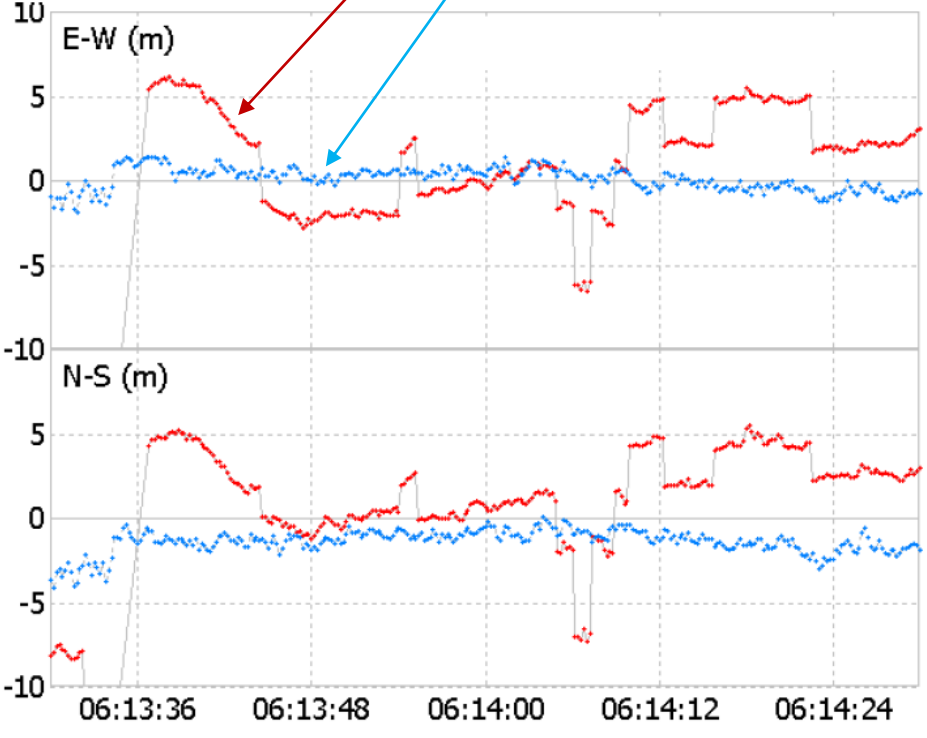


Source: SIP-adus Report “Survey on utilization of satellite positioning information for realization of automated driving system 2015, 2016”

Multi-Pass Reduction

- Using Multi-GNSS, AD car antenna can get signals from many satellites in the sky. Eliminating satellites which may be affected by reflected wave, positioning accuracy is improved because there are still many available satellites.



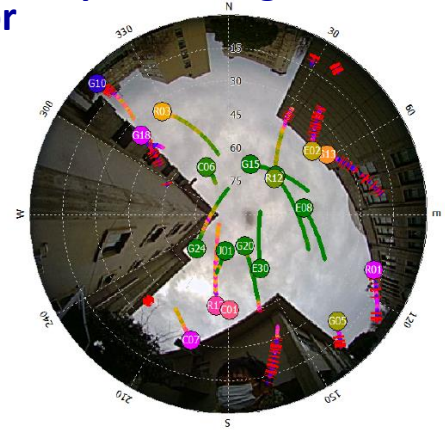


Source: SIP-adus Report "Survey on utilization of satellite positioning information for realization of automated driving system 2015, 2016"

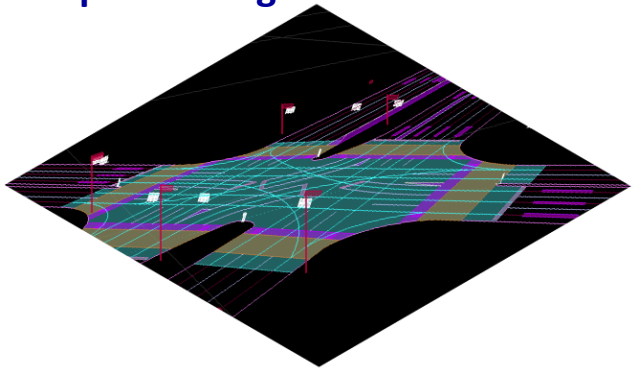
Examination of Error Factors

- In case of using QZSS augmentation signals etc., it is clarified that the main cause of position errors is satellite position and the ground environment such as shielding etc.
- For utilizing the satellite positioning on the dynamic map, because accuracy errors are generated in both maps and satellite positioning sides, it is suitable to use linear positioning information of continuous positioning results or surface model having error amount instead of using the positioning results for each point.

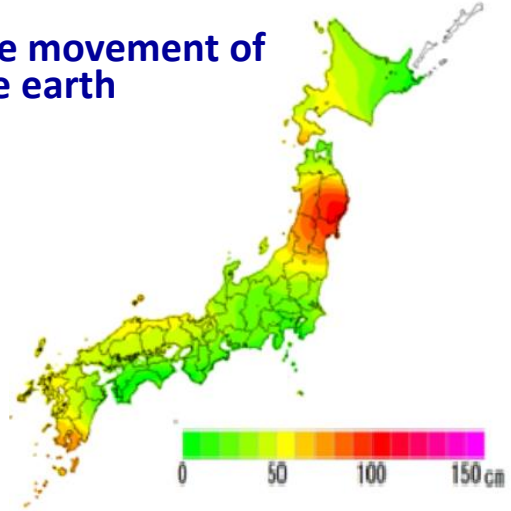
Satellite positioning error



Master data measurement positioning error



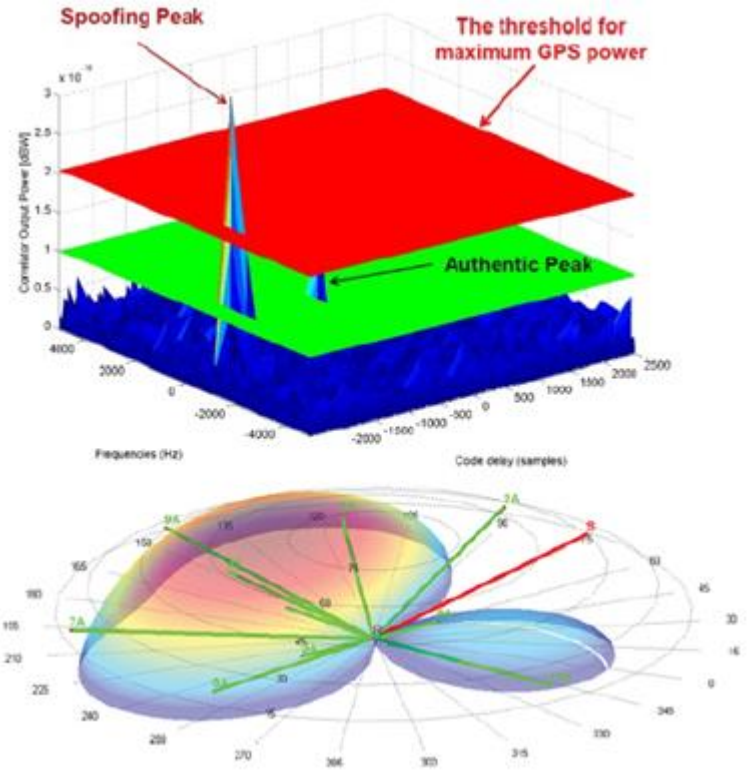
The movement of the earth



Source: SIP-adus Report “Survey on utilization of satellite positioning information for realization of automated driving system 2015, 2016”

Future Challenges

- Establishment of rapid positioning recovery technology in the open sky condition after passing underpass, etc.
- Multi-Pass Reduction algorithm development assuming applicable satellites increase such as Multi GNSS.
- Evaluation of satellite positioning accuracy and study for utilization of satellite positioning on the dynamic map.
- Evaluation of satellite positioning reliability measurement method using composite sensors such as Inertial Navigation System.
- Experiments and evaluation of security attack influence during automated driving.



Security example:

Elimination of attacking signal by array antenna null-setting

Source: SIP-adus Report "Survey on utilization of satellite positioning information for realization of automated driving system 2015, 2016"

4. Goal and the Beyond

AD Field Operational Tests Over View in Japan

➢ Automated Driving Mobility tests to create “Local Smart Mobility Society”.

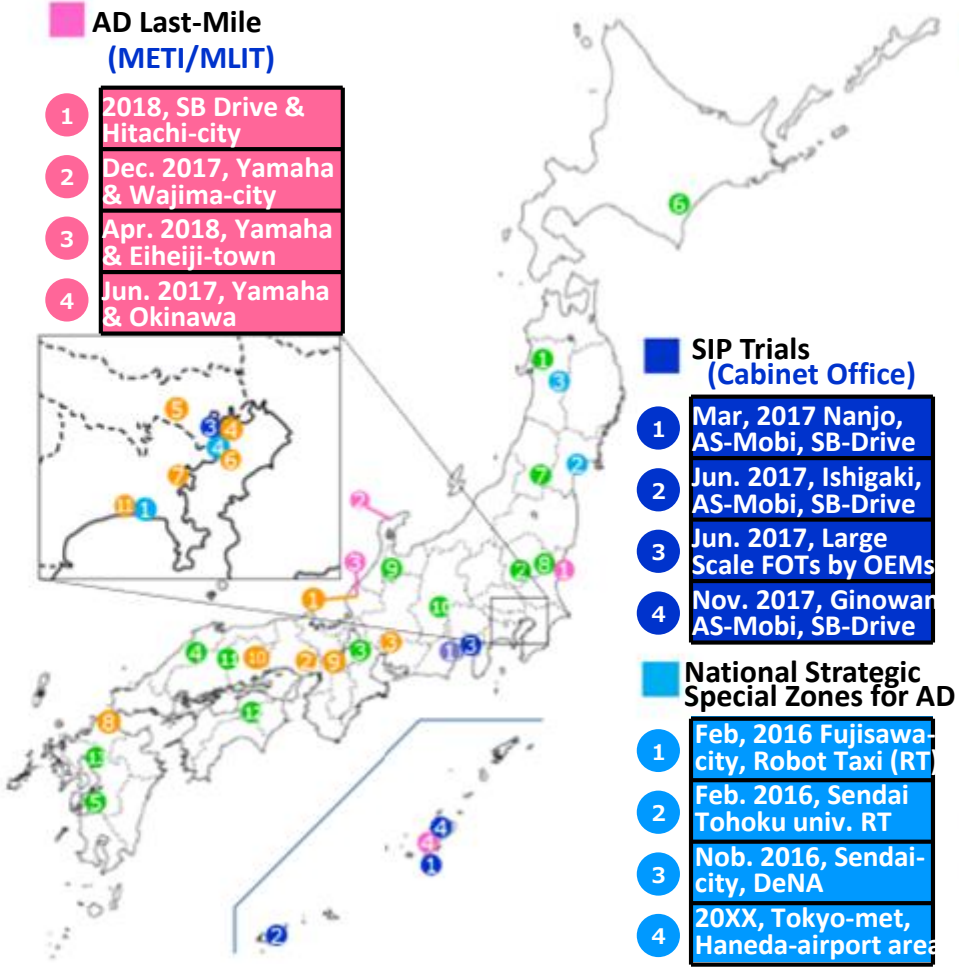
by collaboration of
-Government,
-Local government,
-Academia,
-Private sectors.

AD service from roadside stations (MLIT/SIP)

1. Dec. 2017 Kamikoani, Akita
2. Sept. 2017 Nishikata, Tochigi
3. Nov. 2017 Higashi-Omi, Shiga
4. Nov. 2017 Akagi, Shimane
5. Sept. 2017 Ashikita, Kumamoto
6. Dec. 2017 Daiki, Hokkaido
7. Feb. 2018 Takahata, Yamagata
8. Nov. 2017 Hitachiota, Ibaragi
9. Nov. 2017 Taira, Toyama
10. Feb. 2018 Ina/Alps, Nagano
11. Mar. 2018 Niimi, Okayama
12. Dec. 2017 Miyoshi, Tokushima
13. Feb. 2018 Miyama, Fukuoka

AD Last-Mile (METI/MLIT)

1. 2018, SB Drive & Hitachi-city
2. Dec. 2017, Yamaha & Wajima-city
3. Apr. 2018, Yamaha & Eiheiji-town
4. Jun. 2017, Yamaha & Okinawa



SIP Trials (Cabinet Office)

1. Mar, 2017 Nanjo, AS-Mobi, SB-Drive
2. Jun. 2017, Ishigaki, AS-Mobi, SB-Drive
3. Jun. 2017, Large Scale FOTs by OEMs
4. Nov. 2017, Ginowan AS-Mobi, SB-Drive

National Strategic Special Zones for AD

1. Feb, 2016 Fujisawa-city, Robot Taxi (RT)
2. Feb. 2016, Sendai Tohoku univ. RT
3. Nob. 2016, Sendai-city, DeNA
4. 20XX, Tokyo-met, Haneda-airport area

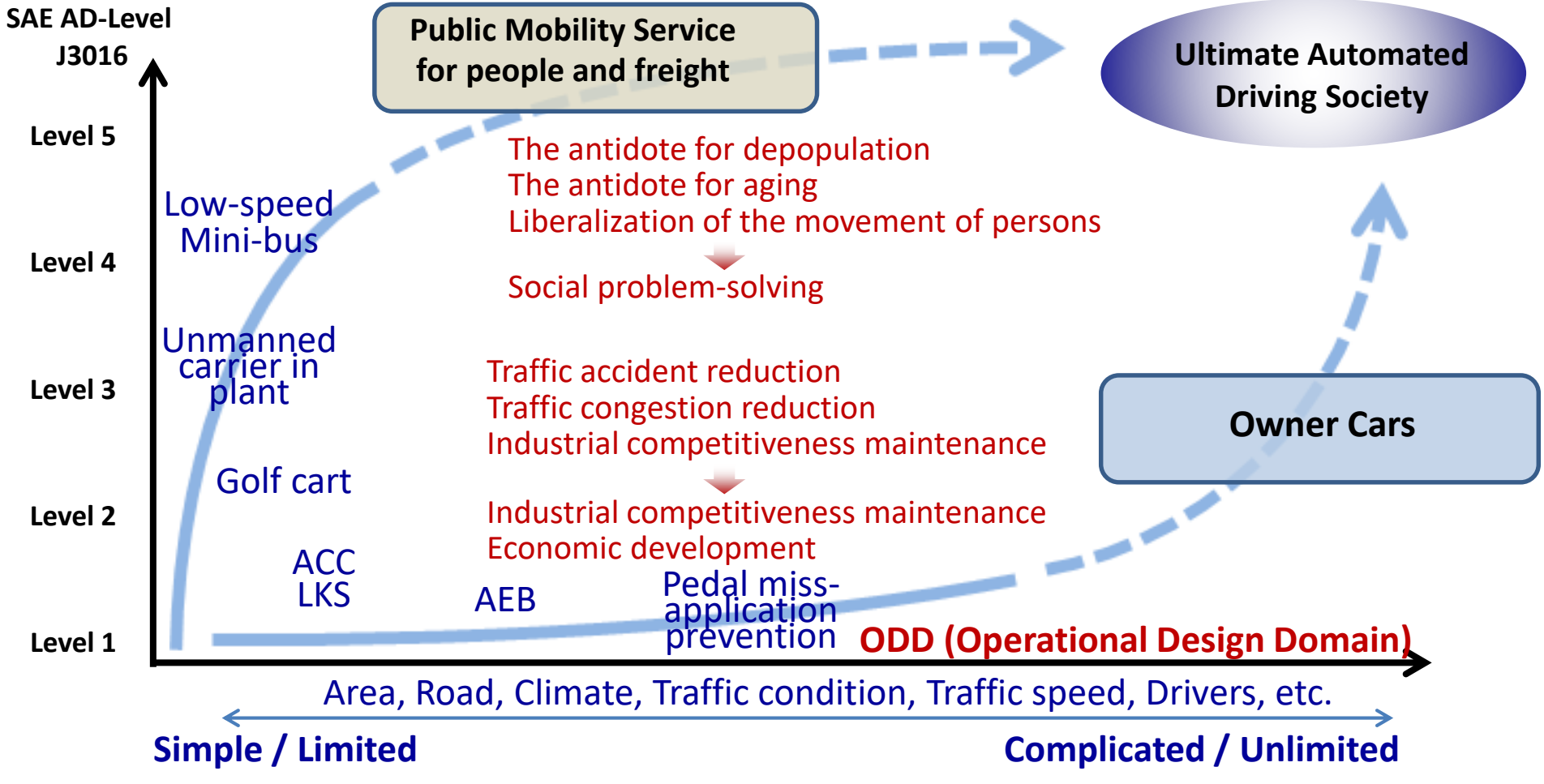
(Local gov. Univ. Private sectors)

1. Oct. 2017 Fukui-pref, Panasonic
2. Nov. 2017 Kobe-city, Gumma univ.
3. Nov. 2017 Aichi-pref, Aisan Tech.
4. Dec. 2017 Tokyo-met, ZMP
5. Jan. 2018 Tokyo-univ. Aisan Tech.
6. Feb. 2018 Haneda airport SB-Dr, ANA
7. Mar. 2018 NISSAN, DeNA, Yokohama
8. Mar. 2018 Kita-Kyushu univ, etc
9. Mar. 2018 Keihanna science city
10. Apr. 2018 Ako-city, SD-Dr. Uno motor
11. Apr. 2018 Fujisawa-city, Kuroneko, DeNA

Trucks Platooning (METI/MLIT)

1. Jan. 2018 Trucks OEMs

Approach for Goal



Second Phase of SIP-adus (FY2018-2022)

- **Targets**
  - ✓ Owner cars: SAE Level 4 (High Driving Automation) on highway by around 2025
    SAE Level 2 (Partial Driving Automation) on ordinary roads.
  - ✓ Public mobility: Low speed SAE Level 4 (Driverless) on limited operation design domain by 2020.
  - ✓ Logistics service: Trucks platooning SAE Level 4 after 2025

- **Seek smooth commercialization exit by commercial-phase-stakeholder participation in R&D. Specifically, promote investment and business planning from private sectors.**
  - ✓ Achievement Strategy → 2020 Tokyo Olympic Games, long term and business trial FOTs

- **Research and Development Topics**
  - ✓ FOTs including infrastructure support, probe technology usage, next generation public transportation, local community transportation, etc.
  - ✓ Development of AD cars safety simulation based evaluation.
  - ✓ Establishment of social understanding and the international harmonization.


Thank you for your attention
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