Automated Driving System

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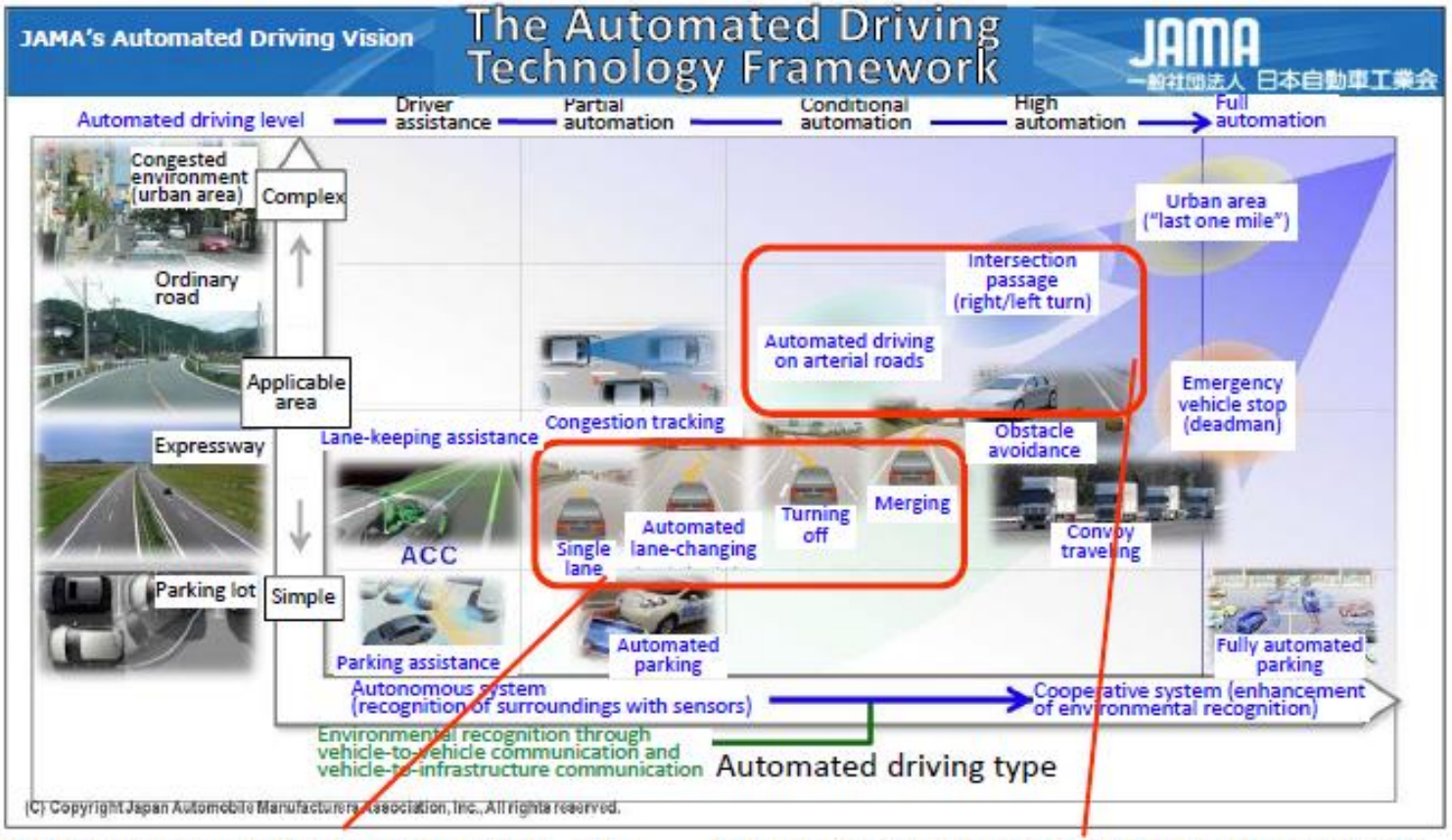
Translated Version

Today's agenda

- SIP Automated Driving System
  - Objectives, R&D Fields, Roadmap
- Results of Development Targeting the 5 Key Issues
  - Dynamic Map
  - Cyber Security
  - HMI
  - Pedestrian Traffic Accident Reduction
  - Next Generation Transport
- Large-Scale Field Operational Tests
- International Cooperation/Overseas Developments
- Toward Realization of Distribution/Transportation Services
- Toward Realization of "Society 5.0"

The SIP Automated Driving System: Objectives

1) Reduction of accidents and elimination of congestion in road traffic
2) Early realization and popularization of an automated driving system
3) Realization of an advanced public bus system that is easy to use by the elderly and disabled road users



(1) Practical application of a high-end semi-automated driving system (Level 2) by 2020

(2) Clarification of functional expandability requirements and priority for next step and scheduling of its deployment

R&D Fields

Vehicle

Recognition

Judgment

Operation

Map, ITS info., sensor

AI

Actuator

HMI*

Human Machine Interface

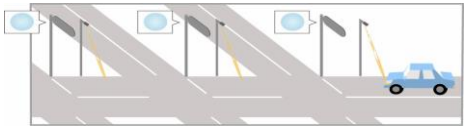
Cooperation w/Human

Important Technologies

- **Self-position estimation**
- **Neighboring environmental recognition**

Dynamic map

High-definition digital map



ITS information

Onboard Sensors

In red: Area of Cooperation ⇒ Main Area of SIP-adus

Base Tech. **Cyber Security, Simulation, Database, etc.**

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

Overall Schedule

2014 → 2015 → 2016 → 2017 → 2018

- ◆ **System development**
- ◆ **R&D on specific themes**

Steering Committee
- System Implementation Working Group
- International Cooperation Working Group
- Next Generation Transport Working Group

- ◆ **Integration into 5 key issues**

(1) Dynamic map

(2) Cyber security

(3) Human machine interface (HMI)

(4) Pedestrian traffic accident reduction

(5) Next generation transport

- ◆ **Large-scale field operational tests**

Deployment

Toward deployment: Advancing development and deployment based on large-scale field operational tests for the “5 key issues”

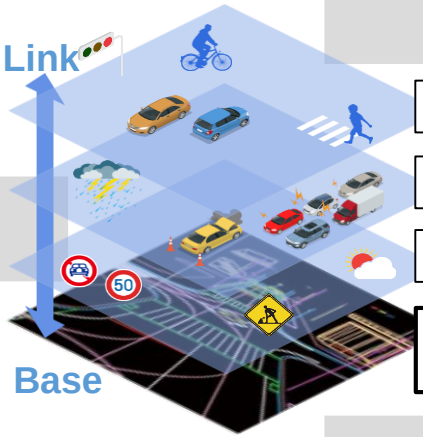
Dynamic Map

Ultimate goal: Realization/commercialization of Dynamic Map Center functions and standardization

Large-scale field operational tests

(FY2017 – FY2018)

1) Preparation of platform data
2) Map update mechanism
3) Quasi-dynamic data collection mechanism
4) Data delivery mechanism



Dynamic Data

Semi-dynamic Data

Semi-static Data

Static Data = **High Definition 3D Map**

5) Standardization

International standardization

Proposal to ISO/TC204 WG3
PWI approved

Coordination with other policies and measures

6) Use of lane-level regulations information
7) Use of probe information
8) Architecture development
9) Development for other purposes

PWI: Preliminary Work Item

10) Commercialization

*Contributions by six companies of the "Dynamic Map Common Platform Study Consortium," Innovation Network Corporation of Japan, and ten car companies

Establishment of business company*

Preparation of high-definition 3D map for all 30,000 km of expressways by the end of 2018

Results and future activities	Determination of high-precision 3D map specifications, proposal of international standardization⇒ Tying of existing traffic information, development of data update/delivery mechanisms, expanded application to other fields

HMI (Human Machine Interface)

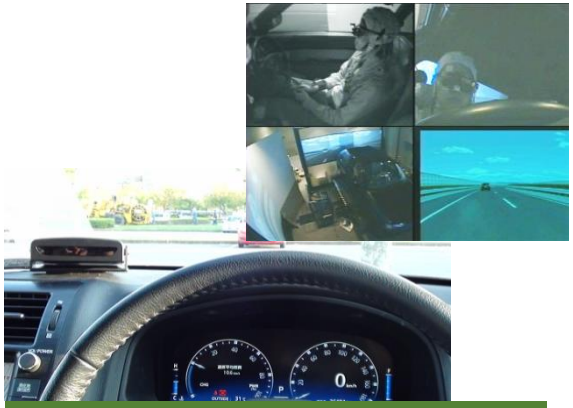
Ultimate goal: Formulation of HMI guidelines for realization of automated driving Level 3 and international standardization

Issue A: **Pre-knowledge and instruction method** for automated driving system functions, situation, and behavior that must be provided to the driver for appropriate driving

Issue B: Detection of **the driver's readiness** (development of driver monitoring devices) and clarification of the time required for take-over

Issue C: Identification of the **interface with other traffic participants** that automated vehicles will require

Driving behavior study using driving simulators



Measurement of driver readiness and trial production of measurement devices

Fact-finding study of communication among traffic participants

Results and future activities

Clarification of human factors for realization of Level 3 and 4
⇒ Preparation of HMI requirement guidelines (readiness indicators, etc.) and international standardization using data-gathering and the results of analyses conducted in actual traffic environments

Cyber Security

Ultimate goal: Establishment of evaluation methods at the vehicle level and component level and international standardization

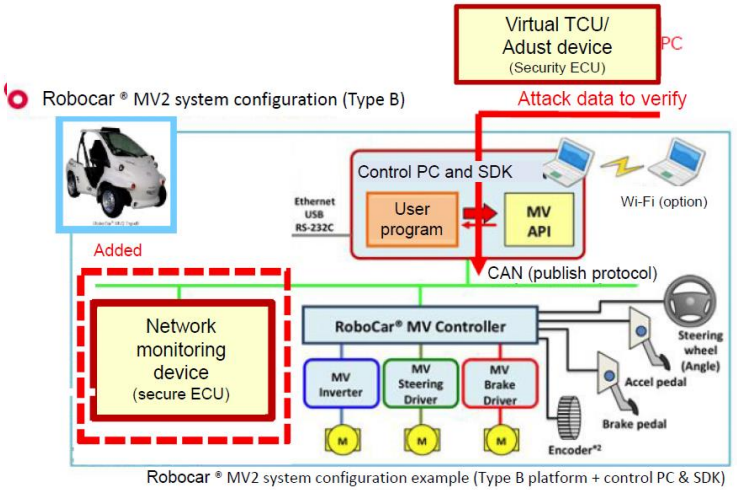
【Threat analysis: Development of **threat analysis methods** and determination of tool specifications based on a threat database

Characteristics: Incorporation of multilayered defense strategies, linkage with JAMA/JasPar specifications

Evaluation method: Development of an **evaluation simulator** and **evaluation method** for components/in-vehicle LAN

Characteristic: Development of behavior detection and evaluation

Component-level evaluation environment (CAN bus)



Robocar ® MV2 system configuration example (Type B platform + control PC & SDK)

Onboard LAN evaluation environment (CAN bus)

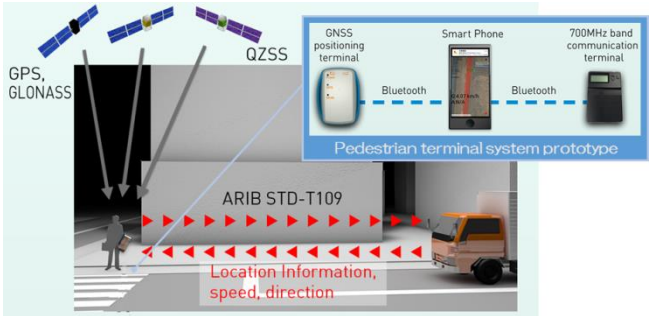
V2X signature validation: Development of a message validation protocol with priority levels

Characteristic: Realization of high-speed message validation of 1,000 messages/second through simple signature validation

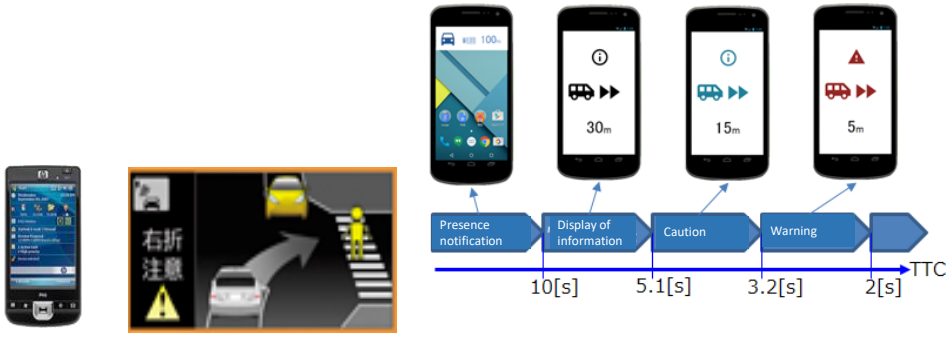
Results and future activities	Development of a component-level evaluation method and simple signatures ⇒ Development of a method for security evaluation from outside the vehicle (black box evaluation) and preparation of guidelines

Pedestrian Traffic Accident Reduction

Ultimate goal: Development of technologies for measuring pedestrian location data and pedestrian terminal systems



Highly-precise pedestrian localization and behavior prediction



Caution function using vehicle-to-pedestrian communication terminals

■ Target of achieving localization accuracy of ±20 m ⇒ ±5 m in a multipath environment by combining technologies for eliminating errors in satellite measurements, **pedestrian dead reckoning (PDR)**, and Doppler velocity to correct movement distance and direction

■ Simplification of the method for **refining** judgment of identified possible hazards with the **direction of movement, distance, and speed of both pedestrians and vehicles**
■ Development of an HMI that **provides notifications corresponding to localization error and hazard level**

Results and future activities	Goal of developing base technologies for localization and sensing technologies for pedestrian communication terminals ⇒ Improvement of malfunction and inoperability rates on public roads and confirmation of pedestrian behavioral modification studies, social acceptance of services, etc.

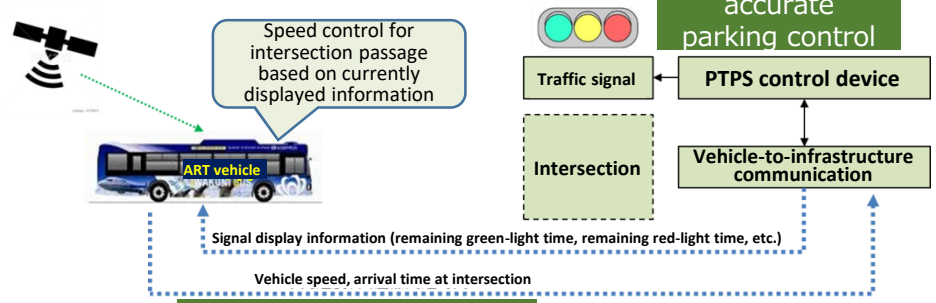
Next Generation Transport

Ultimate goal: Proposal of Next Step ART*1 and its promotion with demonstrations

*1 ART: Advanced Rapid Transit

■ Goal of developing technology for realizing **automated accurate parking control** at bus stops (better on/off efficiency) and **enhanced PTPS** (express performance)

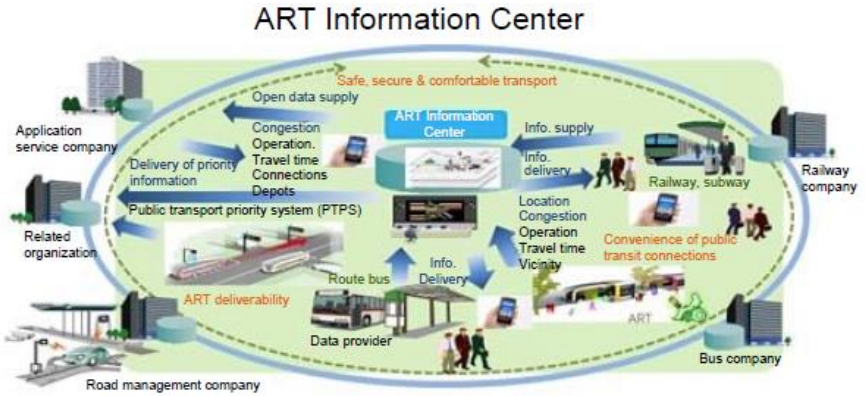
Automated accurate parking control



Enhanced PTPS*

*PTPS: Public Transportation Priority System

■ Development of basic structural specifications for a platform for **ART Information Center functions** using vehicle operating information, dynamic map information, etc.



ART Information Center Functions Scheme

Results and future activities	Goal of developing base technologies for realizing ART ⇒ Ascertainment of the convenience of specific technologies and functions, social acceptance of enhanced PTPS, commercial feasibility of ART Information Center functions, etc., through field operational tests

Moving toward Deployment: Large-Scale Field Operational Tests

Providing opportunities for **open discussion** through large-scale operational tests on public roads.
Accelerating the **deployment** and **standardization** of dynamic map specifications in cooperation with domestic and foreign manufacturers.

Specific initiatives

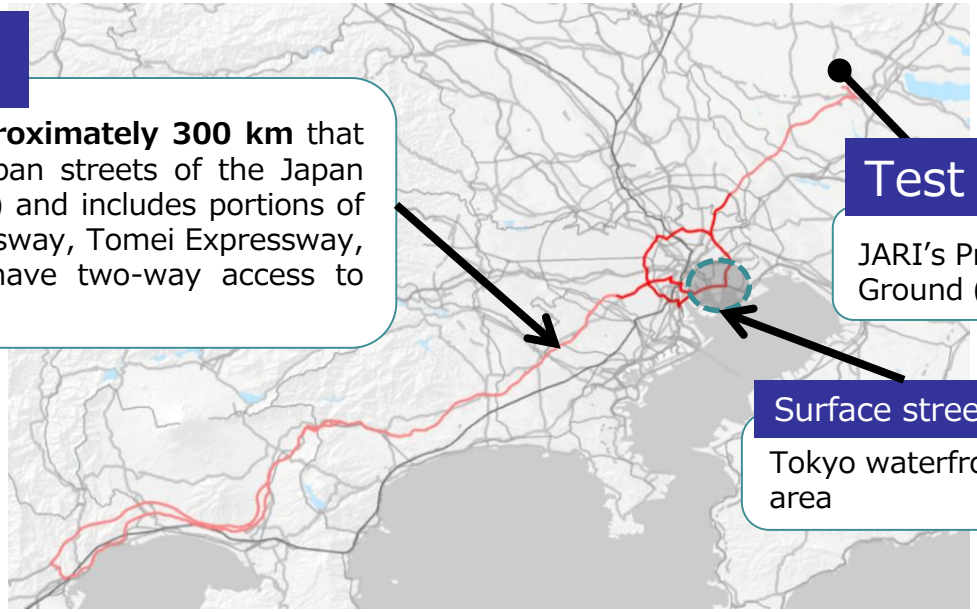
- Building an open test environment by preparing digital infrastructure
- Activation of the study/technology development with the participation of manufacturers/research institutes
- Establishing a venue for discussion based on international cooperation by inviting foreign manufacturers
- Test planning with an eye to deployment and commercialization
- Holding social demonstrations and social acceptance-building events to achieve early social implementation

Outline of Large-Scale Field Operational Tests

Test locations

Expressways

An area with a **total length of approximately 300 km** that starts at a test course imitating urban streets of the Japan Automobile Research Institute (JARI) and includes portions of the Joban Expressway, Shuto Expressway, Tomei Expressway, and Shin-Tomei Expressway that have two-way access to ordinary roads



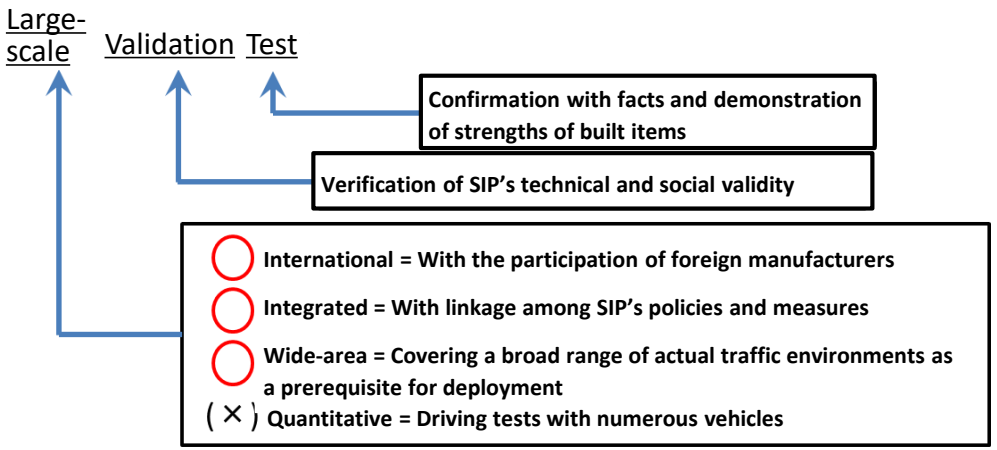
Duration and test periods

October 2017 to end of FY2018

(Test periods will be set individually depending on the content of the test.)

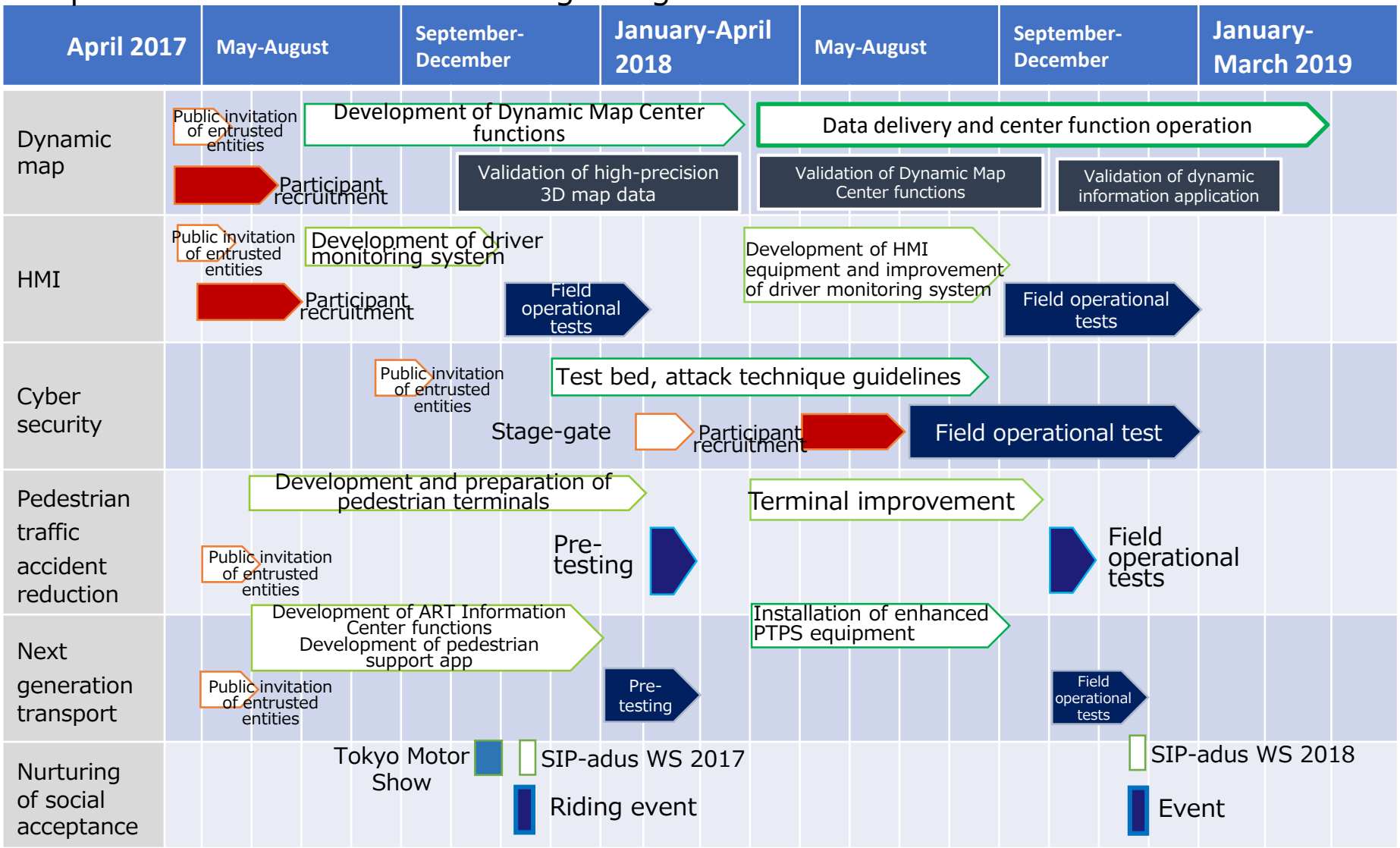
Envisioned participants

・Domestic car manufacturers/component suppliers
・**Foreign car manufacturers/component suppliers**
・Universities/research institutes
・Concerned ministries and agencies/journalists



Large-Scale Field Operational Test Schedule

Sequential start in each theme beginning in October 2017



*The schedule for FY2018 may change.

International Cooperation

Results thus far	Establishment of an SIP contact point for six key international cooperation themes and continuous participation in international conferences in the US and Europe and teleconferences → Formation of a US-Europe-Japan network centered on SIP

- Dynamic Map
- Connected Vehicles
- Human Factors
- Impact Assessment
- Next-generation Transport
- Cyber Security

○ Third SIP-adus Workshop 2016

SIP-adus : Innovation of Automated Driving for Universal Services

Dates: November 15 to 17, 2016　Venue: Tokyo International Exchange Center

Participants: 61 speakers (**34 from outside Japan**), including Yosuke Tsuruho, Minister of State for Science and Technology Policy; Finland's Minister of Transport and Communications; and Dr. Kazuo Kyuma, full-time member of the Council for Science, Technology and Innovation　425 total participants (**50 from outside Japan**)

⇒ The Fourth SIP-adus Workshop 2017 is scheduled to take place on November 14 to 16, 2017

○ Japan-Germany cooperation for promoting R&D on automated driving system technology

German Minister of Education and Research Wanka and Japanese Minister of State for Science and Technology Policy Tsuruho signed and announced cooperation in Berlin, Germany, in January 2017.
⇒ A **Japan-Germany Experts Conference** (provisional name) is scheduled to meet in Tokyo on **November 13, 2017**.

Overseas Developments involving Automated Driving

SIP 見えてきた未来 社会での実用化 SIPシンポジウム 2017

Automated driving technology demonstrations

Smart Cities Challenge (United States)
The US Department of Transportation has been demonstrating automated vehicles on a city-wide basis in Columbus, Ohio, since June 2016.

Audi (VW Group) (Europe)
n September 2016, Audi announced it is conducting field operational testing of prototype vehicles (Level 3 and above) on the Autobahn and other areas of Germany.

Adaptive Project (Europe)
This is the largest comprehensive automated driving project. It is being conducted by EU member states under the Framework Programme (FP7).

Google (United States)
Google's autonomous cars surpassed approximately 3.2 million kilometers of driving on public roads in October 2016.
(Testing is currently being conducted under an independent company called Waymo.)

Transportation service demonstrations

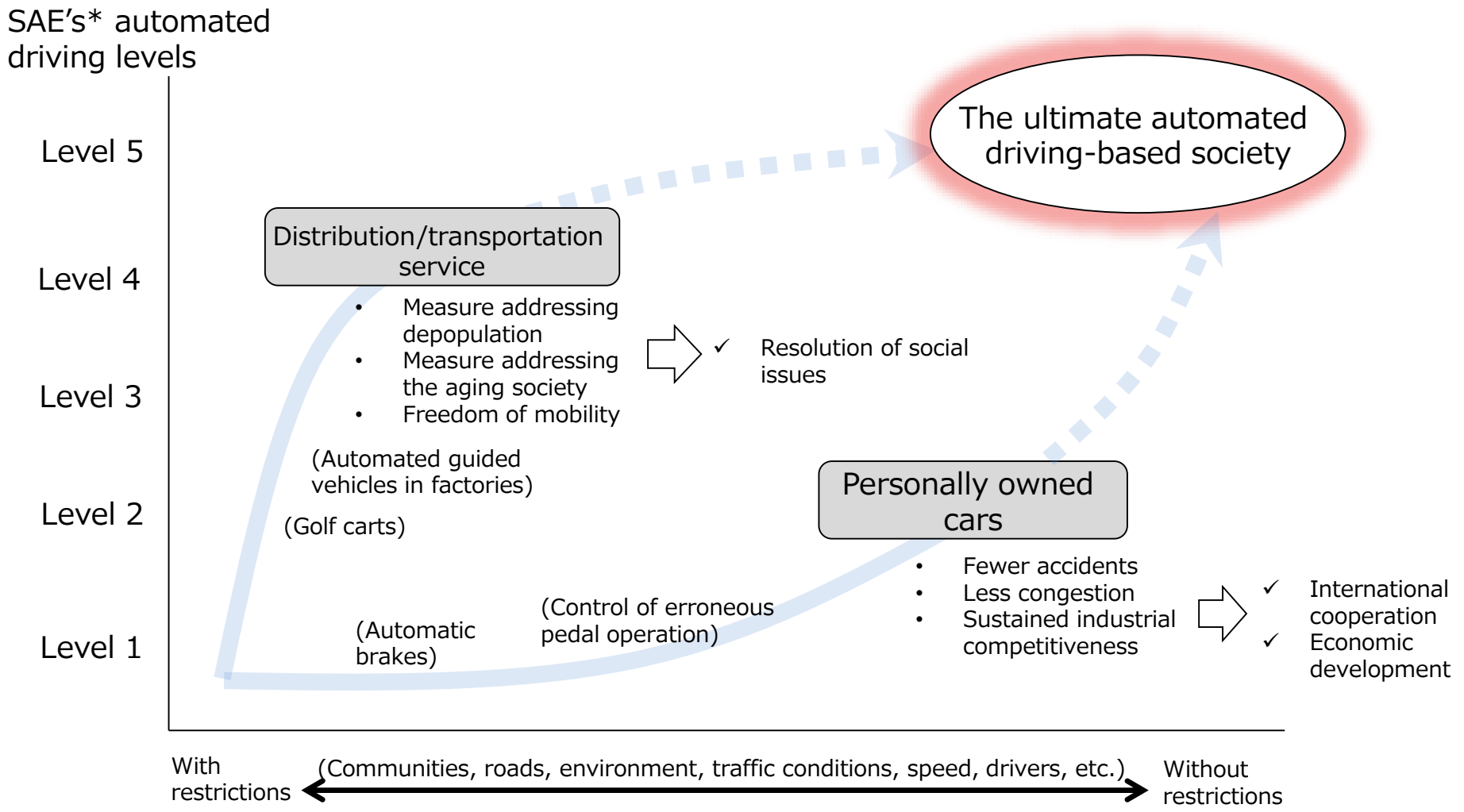
Waymo of Alphabet Inc. (United States)
In April 2017, Waymo announced that it would conduct a social demonstration **of transportation services** by lending **autonomous cars** to ordinary households in Arizona.

Uber Technologies Inc. (United States)
Uber began demonstrating a **taxi service** that uses **autonomous cars** in May 2016.

Drive Sweden Project (Europe)
This is a collaborative industry-government-academia project concerning comprehensive **transportation services**, including **automated driving, connected vehicles, and ride-sharing**.

Easymile (Europe)
Easymile began test-driving **self-driving buses** on public roads in Finland in August 2016.

Automated Driving Approaches and Roadmap of the Automated Driving System

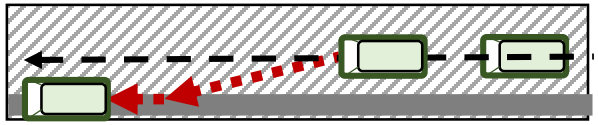


SAE: Society of Automotive Engineers (a standardization organization of the United States)

Regional demonstrations of transportation services that address social issues

○ Field operational tests of automated-driving buses in Okinawa

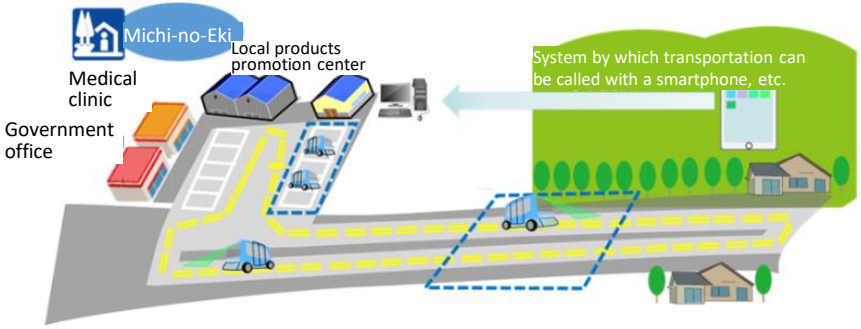
An automated-driving bus field operational test is being conducted in Okinawa, where the reorganization of public transport systems is being discussed as a first step toward regional development. The demonstration is being sequentially expanded to regions with heavy traffic volume.
(Cabinet Office bureaus in charge of Okinawa affairs, Okinawa Prefecture, concerned municipalities)



Demonstrations of automated accurate bus-stop parking are also taking place.

○ Social implementation of automated driving in hilly and mountainous regions

The social implementation of automated-driving services based at "**Michi-no-Eki**" roadside stations is proceeding to meet daily transport needs in hilly and mountainous regions where many people of advanced age live.
(The project is establishing and operating regional test councils establish at 13 Michi-no-Eki throughout Japan.)



Promoting multipurpose use of dynamic maps for the realization of Society 5.0

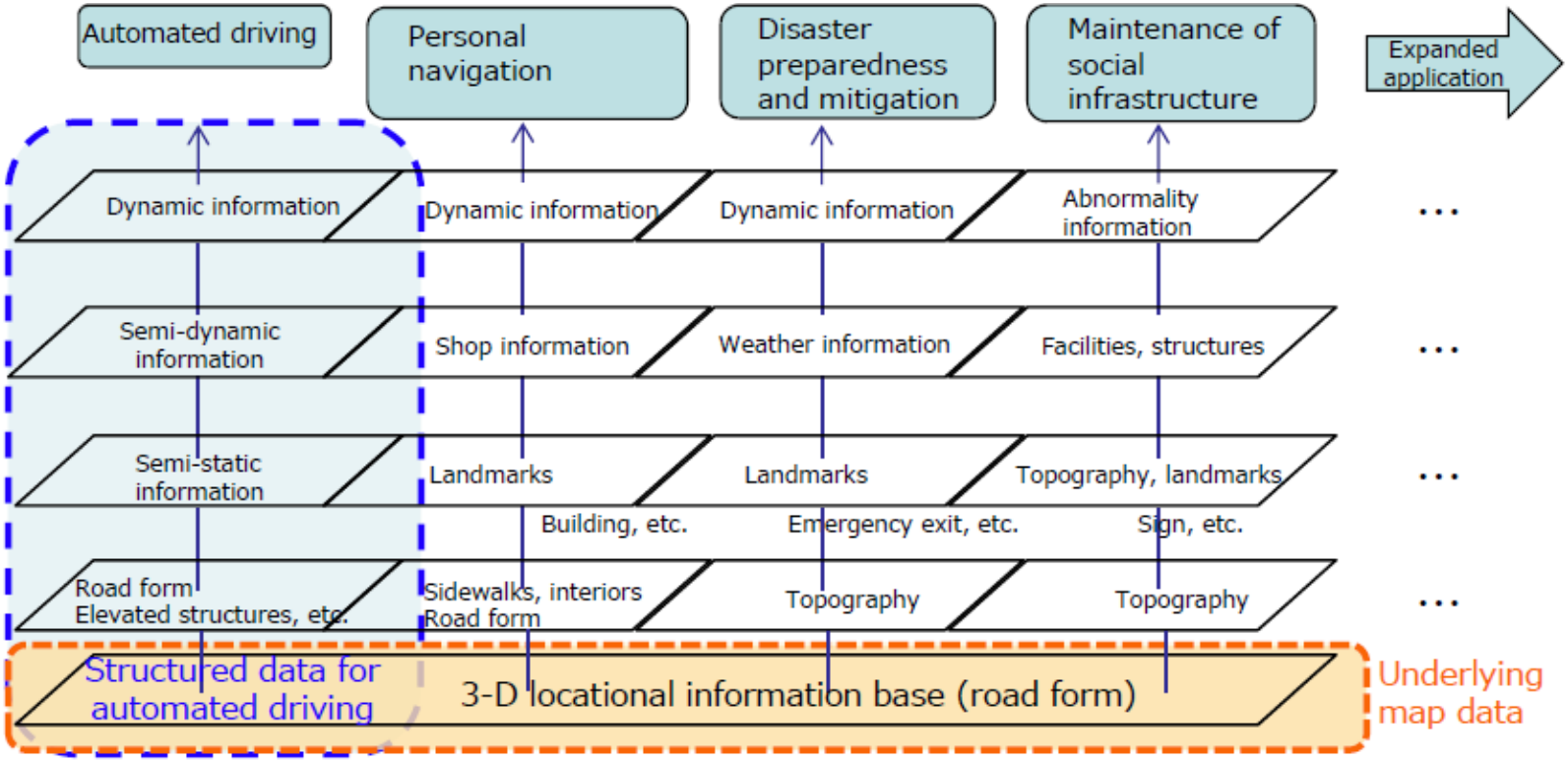
Society 5.0: A “Super Smart Society” (Fifth Science and Technology Basic Plan)

(1) Sophisticated integration of cyberspace with physical space

(2) Simultaneous pursuit of economic development and resolution of social challenges

(3) Realization of a human-centered society that permits a high quality of life

Multipurpose use of dynamic maps



Multipurpose Use of Dynamic Maps

○ Infrastructure management and public use in disaster preparedness and mitigation

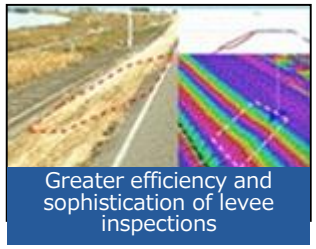
Aiming for certification of "Public Survey Results"

Creation of rules concerning surveying and quality inspection based on consideration of what is required by current public surveying regulations

MMS: Mobile Mapping System

Survey and study of cases where applicability exists

Preparation of base maps (roads, public/private-sector surveys)



Greater efficiency and sophistication of levee inspections

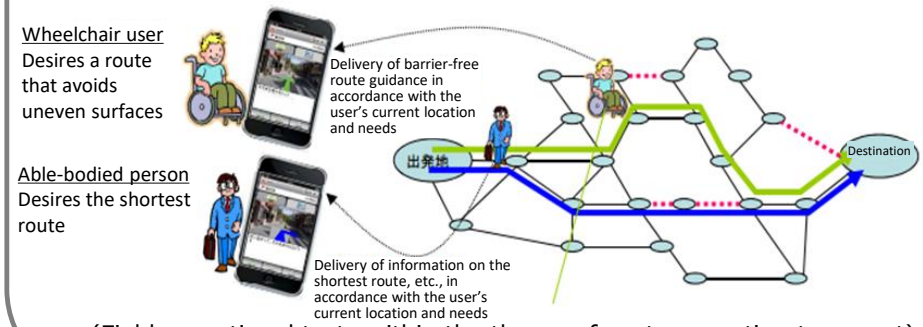
Seismic retrofitting of emergency routes

*Proposal of other new applications in local governments, etc.

(Cooperation with Gifu Prefecture, Geospatial Information Authority of Japan, Gifu University, SIP's infrastructure management/disaster preparedness and mitigation)

○Pedestrian support guidance

Pedestrian guidance system utilizing high-definition 3D map that also helps people with limited mobility



(Field operational tests within the theme of next generation transport)

○ Use in "smart" farm machinery

Application to unmanned operation of farm machinery as part of automated agriculture

(Cooperation with SIP's next generation agriculture)

Mobility bringing everyone a smile!

Thank you for your kind attention.