Automated Driving System

Freedom of Mobility and Safety through Automated Driving Systems and Advanced Infrastructure

The Automated Driving System is a technology that makes use of real-time information from vehicles, people, and roads. The ultimate goal of this program is to eliminate traffic fatalities. In the near future, developments in safety technologies and local traffic management systems will guarantee for the first time that every person across the world can enjoy freedom of mobility and safety. Reducing traffic accidents is a common concern around the world. The Automated Driving System program seeks to lead the world in developing a next-generation transportation system as social infrastructure for tomorrow.

Program Director

Seigo Kuzumaki

Toyota Motor Corporation
Advanced R&D and Engineering Company
Executive General Manager

Profile

Mr. Kuzumaki received a master's degree in aeronautical engineering from Kyoto University in 1985. The same year, he joined Toyota Motor Corporation in the Body Design Department. In 2003, he began working in technology planning and technical development as the vehicle safety function supervisor in the Vehicle Technology Development Department at Toyota. He has served in his present post since 2017. Following his appointment as Sub-PD for the SIP Automated Driving System program for two years from 2014, he was appointed PD in 2016.

Research and Development Topics

1. Develop/verify automated driving systems

- Research into commercialization and conduct field operational tests for the rapid deployment of automated driving systems
  - ✓ Improve digital map information
  - ✓ Develop technology to generate predictive information using ITS
  - ✓ Develop technology to improve sensing capabilities
  - ✓ Develop HMI technology for drivers and automated driving systems
  - ✓ Develop technology to system security

2. Advance basic technologies to reduce traffic fatalities and congestion

- Develop technologies for estimating the impact on reducing traffic fatalities; create a common national database
- Develop micro/macro data analysis and simulation technologies
- Visualize CO_2 emissions from regional traffic

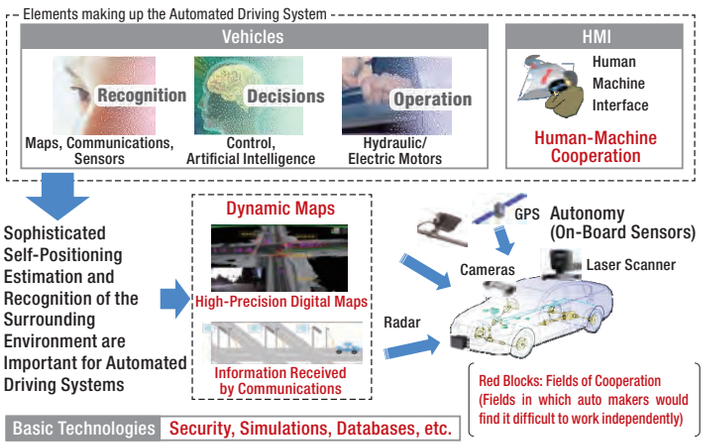
3. Promote international cooperation

- Prepare an internationally open R&D environment; promote international standardization
- Identify six key areas*1 for international cooperation and engage in strategic coordination
- Promote public acceptance of automated driving; develop an international automated driving package for export to foreign markets

4. Deploy next-generation urban transportation

- Improve regional traffic management
- Develop a next-generation transportation system, improve and promote accessibility

●Technical Elements required for Automated Driving Systems, and SIP R&D area (in Red)



5. Conduct large-scale field operational tests

- Identify five key issues*2 for accelerating practical application of automated driving systems and conduct large-scale field operational tests
- Integrate R&D measures and uncover institutional and other issues

6. Other

- Strengthen industry-academia partnerships, and coordinate with other SIP programs
- Exercise leadership related to Society 5.0 initiatives

*1 Six areas of high interest in international discussions:
Dynamic Maps, Connected Vehicles, Human Factors, Security, Impact Assessment, Next-generation Transport

*2 Key issues addressed by the SIP Automated Driving System program:
Dynamic Maps, HMI, Information Security, Pedestrian Accident Reduction, Next-generation Urban Transportation

Exit Strategies

☑ Accomplish national goals (reduce traffic fatalities, etc.)

Build a technological foundation for traffic safety policies that encompass vehicles, citizens, and infrastructure as needed to accomplish the national goals of reducing traffic fatalities, etc.

☑ Realize and diffuse automated driving systems

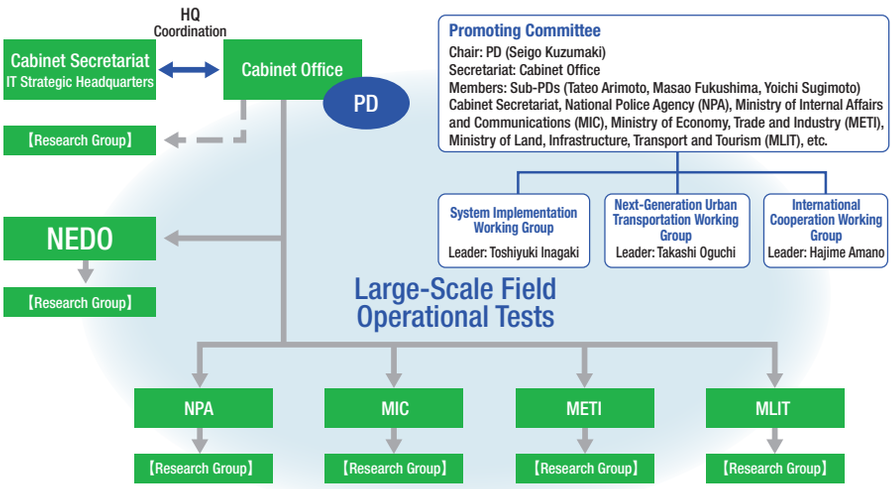
Using ITS-based predictive information, advance R&D in cooperative fields and secure necessary technologies to commercialize SAE Level 2 automated driving systems (utilizing signal, traffic congestion and other infrastructure information) by 2017, SAE Level 3 by 2020 and SAE Level 4 by 2025. Also, through these achievements, create new industries that extend beyond the framework of the current automotive industry.

☑ Engage in collaborative development with the Tokyo Metropolitan Government, setting the 2020 Tokyo Olympics/Paralympics as a milestone

Work toward the 2020 Tokyo Olympics/Paralympics as a milestone for introducing a next-generation public transportation system (Advanced Rapid Transit; ART) that both promotes the city of Tokyo and addresses Japan's aging population, contributing value for future generations. Develop a packaged transportation management and infrastructure product as a new export business.

Implementation Structure

Under the leadership of the Program Director (PD), the Promoting Committee sets directions for and manages research and development under this program. Three working groups (WGs) serve as forums for discussing specific research and development topics (Systems Implementation WG; International Coordination WG; Next-generation Urban Transportation WG). Under this format, the program works to accelerate the practical implementation of technologies, ascertaining those cooperative fields requiring industry-academia-government coordination and those fields in which manufacturers should compete with each other. The program leverages the government's existing framework for promoting Intelligent Transport Systems (ITS), taking direct charge of research fields under the jurisdiction of various ministries and agencies. In this manner, the government aims to accelerate the promotion of policies and spend budgets efficiently.

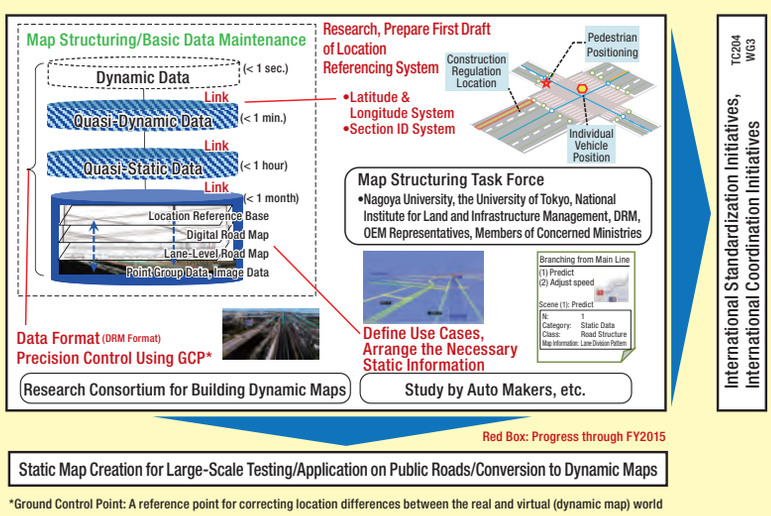


Progress to Date

Developing Dynamic Maps (Sophisticated 3D Map Data for Automated Driving)

Sophisticated automated driving systems are difficult to achieve using on-board technologies alone. These systems must be capable of automatic control using vast amounts of information, some of which is constantly changing (e.g. map and road data, traffic regulations, and location information for other vehicles). This program is working in a public-private partnership to develop dynamic maps that integrate this wide variety of information. This highly sophisticated map data will be available for the use of all vehicles, not just automated vehicles.

•Dynamic Map Structure



*Ground Control Point: A reference point for correcting location differences between the real and virtual (dynamic map) world

Program Director **Seigo Kuzumaki** Interview

Large-scale Testing on Public Roads in 2017! Automated Driving System Closer to Becoming a Reality

Automated driving systems are one area of research closest to becoming a reality for Society 5.0, an integration of cyberspace and physical space. Under Society 5.0, social transportation will be safe, comfortable, and convenient thanks to the harmonization of vehicle and traffic systems between which various pieces of data flit about. Today, we are closer than ever to seeing this society become a reality.

Program Director (PD) Seigo Kuzumaki says confidently, "Our work is progressing as planned. In the autumn of 2017, we will start large-scale testing of automated driving systems on public roads."[*1]

The SIP Automated Driving System program is managed under an existing public-private framework to further Japan's Intelligent Transport Systems (ITS). At present, this program is conducting research and development toward the practical application of automated driving systems. While the program has addressed a wide range of topics related to automated driving technologies, these topics have been largely consolidated into five key issues.[*2]

Using Quasi-dynamic Information to Achieve an Automated Driving System by the Year 2020

The rapid evolution of automated driving technology over the past two years backs up Mr. Kuzumaki's statements. Sensors have become more precise, while software and HMI technologies have advanced to a significant degree. Despite the difficulties involved, driver support technology (e.g. automated freeway merging/exiting) is now close to becoming a reality.

However, Kuzumaki says, "On-board sensor technology by itself is not enough to achieve an automated driving system. You need self-positioning technologies that coordinate with extremely precise 3D map information. You also need technologies that use traffic regulation information and position information for nearby vehicles to recognize the surrounding environment. In this program, we are trying to achieve this level of sophistication through the technologies of dynamic maps, HMI, security, and databases. Here, we are working on a collaborative basis for technologies that would present challenges for auto makers working on their own. The Japanese automobile industry faces stiff technological competition with the United States and Europe. One distinctive aspect about the SIP is that the program engages in focused cooperative research and development for certain fields, while allowing for free private-sector competition in others.

The ultimate aim is to realize a highly advanced automated driving system. Mr. Kuzumaki states definitively, "We will achieve a highly advanced (SAE Level 2) automated driving system by the year 2020, as a step toward an SAE Level 3 system." One more major target of this program is to achieve a national goal of reducing traffic fatalities to fewer than 2,500 by the year 2020 (compared to 3,904 fatalities in 2016). Other targets include reducing traffic congestion and creating a public bus system more accessible to the elderly and people who face restrictions in transportation.

Establishment of Operating Company to Perform Support Center Functions

"We have focused much of our efforts on building dynamic maps," says Mr. Kuzumaki. A dynamic map is one that links constantly changing dynamic data (dynamic information, quasi-dynamic information, and quasi-static information) onto a high-precision 3D map (basic map: static information).

Depending on the need, dynamic maps update information in different time increments. Conceptually speaking, signal information, information about vehicles and pedestrians in the surrounding area, and other dynamic information is updated within the second, reflected on a display panel and in operations of an automobile. Information about accidents, congestion, local weather, and other quasi-dynamic information is updated within the minute, while information about traffic regulations, road construction, area weather, and other quasi-static information is updated within the hour. Static information, including information about road surfaces, lanes, 3D structures, etc. is updated on a daily basis. The automatically controlled vehicle will acquire updated information in real time, using this data for driving control as needed.

The establishment of Dynamic Map Platform Co., Ltd. following the transformation of Dynamic Map Planning Co., Ltd. into an operating company in June 2017 is one example of how this program has stimulated the private sector. Mr. Kuzumaki notes, "The new company will take over the support center function for collecting and distributing dynamic map information. At the same time, SIP will be working to expand applications for dynamic maps and establish international standards for dynamic map specifications."

*1 Mr. Kuzumaki was named PD in April 2016, replacing Hiroyuki Watanabe
*2 Dynamic Map, HMI, Information Security, Pedestrian Accident Reduction, Next-generation Urban Transportation

Automated Driving System

Automated Driving Research to Give Concrete Example of How "Society 5.0" Grows

The government's 5th Science and Technology Basic Plan, adopted by Cabinet decision in January 2016, details Society 5.0, a first-of-its-kind model for a future super-smart society. Automated driving systems are one area of research closest to becoming a reality under this model. Mr. Kuzumaki, director for this program, draws a specific picture for automated driving systems.

"Automated driving systems will collect a variety real-time information related to the surrounding physical spaces. The system will store, analyze, and process this information in cyberspace. We believe this data should be used for basic technology shared across different fields of specialization. Technologies capable of extracting pedestrian information or other specific data from the vast amount of data available may then use this data as part of an artificial intelligence network." Mr. Kuzumaki is eager to use traffic information as an initial gateway to achieving Society 5.0.

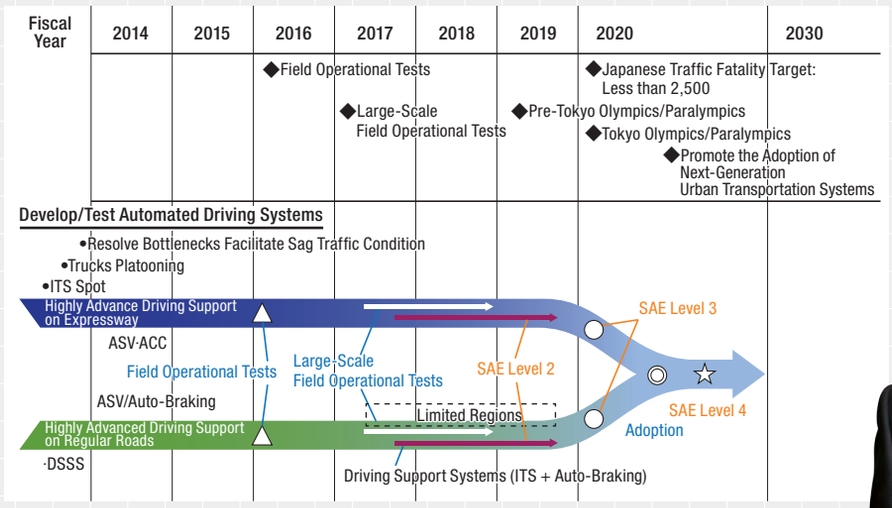
Besides making road transportation safer and more secure, the Automated Driving System program also intends contribute to social value in a number of other ways, including providing support to traffic regulators and resolving the lack of drivers in rural areas. The basic goal of this program is to strengthen the competitive capacity of Japan's auto industry, expanding the market for related industries and boosting industrial value in the nation. The Automated Driving System program will continue to advance research and development in support of these goals.

Future Plans

Working toward creating a highly advanced automated driving system, the program will engage in research and development focused on five key issues: Dynamic maps, HMI, Information Security, Pedestrian Accident Reduction, and Next-generation Urban Transportation. The program plans to begin a sequence of large-scale field operational tests beginning in autumn 2017.

In line with the goals and pace of progress in the auto industry, the program aims to produce a practical system (SAE Level 2) by 2017 that uses signal, traffic congestion, and other information. By 2020, program researchers hope to complete a highly advanced (SAE Level 2) system featuring automated lane changing, exiting and merging functions. The Japanese government plans to introduce a SAE Level 3 system to the market by around the year 2020, with a SAE Level 4 system available by 2025.*3

*3 The timeframe of targets has been set by the Japanese government to enable commercialization by the private sector.



Our goal is to create safe, secure, and convenient transportation that is also accessible to the elderly and people who face restrictions in transportation. Our research is also leading to the creation of traffic infrastructure that can be exported to other regions.